THE CONTEMPLATION OF NATURE.

VOL. II.


BRITISH MUSEUM

THE CONTEMPLATION OF NATURE.

Tranſlated from the French of C. BONNET,

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THE

THE CONTEMPLATION OF NATURE.

PART X.

Parallel between Plants and Animals.

CHAP. I.

INTRODUCTION.

IN our researches into the gradual progression of beings and organical œconomy, we had frequent occasion to compare vegetables and animals with each other. Let us here collect in one point of view those various marks of analogy which are scattered hither and thither; let us represent them as in a picture, wherein, by a nearer and more limited description of them, they will agreeably attract our attention. We will afterwards inquire if there be any character which essentially distinguishes the *vegetable* from the *animal*.

CHAP. II.

The Seed.

A Fecund *ſeed* is an organized body, which under various coverings, thicker or thinner, and more or leſs numerous, contains within it a plant in miniature.

A whitiſh ſubſtance, of a delicate and ſpongy nature, fills the capacity of the ſeed. Small veſſels, which proceed from the germ, are in every part of this ſubſtance, dividing and ſubdividing it continually.

After being laid in the earth, moiſtened, and warmed to a certain degree, the ſeed begins to ſhoot up. The moiſture, which has penetrated its outward folds, diſſolves the ſpongy or meally ſubſtance, and mixes with it. Of this mixture is formed a kind of milk, which, being carried to the embryo by the little veſſels, furniſhes it with a nouriſhment adapted to its extreme delicacy.

The *radicle* or *little root* begins by this means to unfold itſelf. It increaſes in bulk and extent every day. In a ſhort time it becomes ſenſible of too cloſe a confinement: it makes an effort to come forth. A ſmall orifice, made in the exterior ſurface of the ſeed, facilitates its egreſs. The root inſenſibly ſinks into the earth, and derives from thence more ſubſtantial and copious nouriſhment.

The ſmall *ſtalk*, which till this time lay hid under the coverings of the ſeed, now begins to ſhew itſelf. The teguments unfold themſelves, in order to admit a free paſſage for it. Strengthened by an acceſſion of freſh juices, it pierces through the earth, and advances into the air.

CHAP.

CHAP. III.

The Egg.

A Fecund *egg* is an organized body, which under divers teguments, of various ſtrength and number, incloſes an animal in miniature.

A fluid matter, of a juicy glutinous nature, fills the inſide of the egg. A number of infinitely ſmall veſſels ſpread themſelves out in this matter, and are connected with the germ by different branches.

Being warmed in a ſufficient degree, either by nature, or by the help of art, the inſide of the egg begins to receive life. By means of a gentle heat, the matter ſurrounding the germ inſinuates itſelf into the ſmall ramifications, from whence it paſſes into the heart, whoſe motion it augments. Thus the animal becomes a living creature. It increaſes in ſize and ſtrength every day, by receiving freſh ſupplies of more nouriſhing and perfect juices.

At length, after theſe juices are exhauſted, the animal has acquired all the growth it was capable of in the egg. It finds the apartment aſſigned it to be much too narrow. The egg is now become a priſon for it; it endeavours to ſet itſelf at liberty. Nature has provided it with an eaſy method of effecting this, either by arming it with inſtruments proper for piercing or tearing the coverings which incloſe it, or by giving to the egg ſuch a ſtructure as favours its efforts. The animal is produced, and enjoys a new life.

CHAP. IV.

The Bud.

THE ſeed then is to the plant what the egg is to the animal. But the plant is not only *oviparous*, but it is likewiſe *viviparous*; and the *fœtus* is the ſame with reſpect to the *animal*, as the *bud* is to the *vegetable*.

Being concealed under the rind, the bud there receives its firſt growth. It is firſt of all minutely incloſed in membranous teguments, analogous to thoſe of the ſeed. It adheres to the bark by ſmall fibres, which tranſmit a nouriſhment to it adapted to its ſtate. When it has arrived to a certain bulk, it penetrates the rind in order to come forth. At its firſt appearance, it bears the infolding coverings along with it, from which it is ſoon releaſed. However, being as yet too feeble to ſubſiſt without the aliment provided by the mother, it continues to cleave to her; and cannot for a long time be ſeparated, without endangering it.

CHAP. V.

The Fœtus.

BEING lodged in the matrix, the *fœtus* there receives its firſt growth. It is there contained at firſt in miniature, in the membranous incloſures reſembling thoſe of the egg. It ſhoots forth ſmall veſſels in the matrix, which convey thither the nouriſhment neceſſary to promote its growth. When it has arrived to a certain ſize, it burſts theſe incloſures, and comes into the world. Sometimes theſe

theſe incloſures accompany it at its iſſuing forth. After it is produced, the little animal is not always able to provide for itſelf without the aſſiſtance of the dam. She muſt ſtill furniſh it with ſuſtenance, which it cannot diſpenſe with the want of, for a certain time, without danger.

CHAP. VI.

The Nutrition of the Plant.

THE *plant* is nouriſhed by the *incorporation* of ſubſtances received from without; theſe matters are very heterogeneous, or highly mixed. Being pumped by the *pores* of the *roots*, or by thoſe of the *leaves*, they are probably conveyed into the *utriculi*, where they ferment and digeſt. They paſs into the *ligneous* fibres*, which tranſmit them to the *proper vaſes*, where they appear under the form of a juice, which is more or leſs coloured or flowing. The ramifications of the proper vaſes afterwards diſtribute them into all the parts, to which they are united by new filtrations.

Tubes made of a ſilvered blade, which are elaſtic, and turned ſpirally like a ſpring, accompany the veſſels which contain the ſap in their courſe. Being appointed for the purpoſe of reſpiration, theſe tubes introduce a freſh elaſtic air into the plant, which prepares and ſubtilizes the ſap, and probably colours it, beſides contributing to its motion: the ſuperfluous matter, or that part which is not ſo proper to be mixed with the plant, is conveyed to the ſurface of the leaves, whence it evaporates by an inſenſible but very copious *tranſpiration*. *Globules*, *veſicles*, or other *excretory organs*, which are diſtributed

* See Part III. Chap. 10.

among the young ſhoots or leaves, procure an evacuation of the groſſer matter, and ſuch as is of a ſtronger conſiſtence.

CHAP. VII.

The Nutrition of the Animal.

THE *animal* is nouriſhed by the *incorporation* of matter which proceeds from without. This matter is very heterogeneous. Being received by the *mouth*, or by other analogous orifices, it is conveyed into the *ſtomach* and inteſtines, where it undergoes different preparations: it paſſes into the *lacteal veins*, and their dependencies, or into other like veſſels, whereby it is tranſmitted into the blood-veſſels, where it appears under the form of a fluid more or leſs coloured, or flowing. The ramifications of the blood-veſſels afterwards diſperſe it into all parts, with which it incorporates itſelf by new preparations.

Pipes compoſed of cartilaginous rings, or of a ſilvered and elaſtic blade, turned ſpiral-wiſe, communicate with the blood-veſſels, or follow them in their courſe. As they are appropriated to *reſpiration*, they introduce into the animal a freſh and elaſtic air, which prepares, attenuates, and probably colours the blood, contributing likewiſe to its motion. The ſuperfluous matter, or ſuch part of it as is improper to be united with the animal, is carried to the ſurface of the *ſkin*, from whence it evaporates by an inſenſible but very copious *tranſpiration* *Glands*, or other *emunctory organs*, placed in different parts of the body, procure the evacuation of the groſſer or thicker matter.

CHAP.

CHAP. VIII.

The Growth of the Plant.

THE *plant grows* by *unfolding*, or the gradual extenſion of its parts in length and width. This extenſion is followed by a certain degree of hardneſs contracted by the fibres. It diminiſhes as the hardneſs increaſes. It intirely ceaſes when the fibres are ſo far hardened as not to yield to the *force* which tends to enlarge their *ſurface*.

The plants which become hardened the lateſt, are thoſe which are the longeſt time in growing. *Herbs* grow and harden faſter than *trees*. Some of them ceaſe to grow at the end of a few weeks, or even a few days. Among the laſt, ſome continue to grow for a great number of years, and even for many ages.

We obſerve analogous differences between individuals of the ſame ſpecies. Some harden ſooner, grow in a leſs degree, or continue ſmaller; others harden later, and become larger.

The bud has nothing *ligneous* or woody in it. Being *herbaceous* in every part of its ſubſtance, it becomes ligneous by degrees. Its ſtalk is formed of a prodigious number of concentric blades one in another, which are diſpoſed according to its length, and compoſe different bundles of fibres, which are themſelves formed of an aſſemblage of a prodigious number of fibrillæ, or leſſer fibres.

At the center of the ſtalk is placed the *pith*; and the ſpaces which are left between the blades, are likewiſe filled with a *pithy* ſubſtance.

From the thickneſs of the blades reſults its growth in width: from the lengthening of the blades its growth in length proceeds. All the blades grow

and harden one after another. Every blade grows and hardens alike ſucceſſively throughout its whole length. That part of every blade which grows and hardens firſt of all, is that which compoſes the *cape*, or baſe of the ſtalk. The blade which grows and hardens firſt, is the innermoſt, or that which immediately encompaſſes the pith. This blade is again covered with another, which, being more ductile or herbaceous, extends itſelf the more. A third blade incloſes this laſt, which, as it hardens ſtill later, is a longer time in its growth. The caſe is the ſame with regard to a fourth, fifth, or ſixth. All theſe thus diminiſhing in thickneſs, and inclining towards the axis of the ſtalk as they approach its upper extremity, form ſo many little cones ingrafted into each other, from whence proceeds the conic figure of the ſtalk and branches.

From the aſſemblage of little cones which become hardened during the firſt year, is formed a cone of a woody nature, which determines the growth of that year. This cone is incloſed in another herbaceous cone, which is only the rind, and which the following year will produce a ſecond ligneous cone, *&c.* When the wood is once formed, it does not extend itſelf any farther.

So that in *cicatrices*, *grafts*, and different kinds of tumours, the rind is the only part that is employed. By ſtretching, thickening, or ſwelling itſelf, the rind inſenſibly recovers the wood, forms a *roll*, and produces excreſcences which are more or leſs conſiderable, in proportion to the eaſe with which it is diſtended, or according to the quantity of juices it receives.

CHAP.

CHAP. IX.

The Growth of the Animal.

THE *animal* grows by *expanſion*, or by the gradual extenſion of its parts in every ſenſe. To this extenſion there ſucceeds a hardneſs in the fibres. The extenſion diminiſhes in the ſame proportion as the hardneſs increaſes. It ceaſes when the hardneſs has arrived to ſuch a pitch, as not to admit of the fibres giving way to the force which contributes to enlarge their coats.

Thoſe animals, in which this hardneſs is formed lateſt, are longeſt in their growth. *Inſects* grow and harden in a much leſs time than *great animals*. Some of them ceaſe growing at the end of ſome weeks, and ſometimes in a few days. Of the latter, ſome continue growing for a great number of years, and even many ages.

One may obſerve analogous differences in the growth of individuals of the ſame ſpecies; ſome of which, that harden later than others, acquire a greater bulk.

The *fœtus*, conſidered in its original ſtate, contains nothing of a bony nature in it. As it is *membranous* throughout its whole ſubſtance, it only becomes *bony* by degrees. The bones are compoſed of a prodigious number of blades, folded in each other; lying according to the length of the bone, and forming various collections of *fibres*, which are themſelves compoſed of the re-union of a great number of *little fibres*.

In the centre of the bone is placed the *marrow*. The ſpaces left between the blades are filled with a *medullary ſubſtance*.

From the thickning of the blades the growth of the plant proceeds. From them lengthening of them, their extending in length reſults. All theſe blades grow and harden after one another. Each blade grows and becomes hard in a like ſucceſſive manner throughout its whole length. That part of the blade which grows and hardens firſt, compoſes the middle or *body* of the bone. This is the innermoſt, or that which immediately incloſes the marrow. This blade is again covered with a ſecond, which, being more ductile or membranous, ſtretches itſelf in a greater degree. A third blade again infolds this, which, as it hardens later than the others, is a longer time in its growth. It is the ſame with reſpect to a fourth, fifth, or ſixth. As they all thus diminiſh in thickneſs, and detach themſelves from the axis of the bone the nearer they approach to its extremities, they form ſo many little *columns* infolded within each other, which increaſe in diameter at their extremities. From hence we deduce the figure peculiar to *long bones*.

The growth of the bone during the firſt year is attributed to the number of blades which become hardened in that year. This bone continues covered over again with a great number of *membranous* or *tendonous* blades, that bear the name of *perioſteum*, which, as they gradually extend and harden, conduce to the increaſe of the bone in every part of it. The bone, when it is once formed, extends itſelf no farther.

Thus in *fractures*, *anchyloſes*, and the different ſpecies of excreſcences, whether natural or accidental, the *perioſteum* is the only part of the bone that labours. By ſtretching, thickening, and ſwelling itſelf, the *perioſteum* reſtores the bone inſenſibly, produces a calloſity, and forms greater or leſs tumours, in proportion to the facility wherewith it extends itſelf,

itſelf, or as it is more or leſs ſupplied with juices, or with ſuch as are more or leſs viſcous.

CHAP. X.

The Fecundation of the Plant.

THE duſt or fine powder of the *ſtamina*, is the principle which fertilizes the ſeed. The piſtil is the place where this fecundation is performed.

Being contained in certain *veſicles*, the *fecundating duſt* is diſcovered in them by a microſcope, under the appearance of a group of minute regular bodies, for the moſt part of a ſpherical or elliptical form, which being moiſtened, open themſelves, and emit a thin vapour, in which there floats a great number of exceeding ſmall ſeeds, which ſeem to move on all ſides. The duſt itſelf, when put into a drop of water, moves ſeveral ways, with great rapidity.

The *piſtil* is compoſed of three principal parts; the *baſe*, the *cups* or *chives*, and the *top*. The *baſe* contains one or more cavities, where the grain is lodged. The *chives* are pipes of a conic form, or a ſort of very long tunnels, whoſe baſe or aperture is turned towards the *top*. This is generally furniſhed with ſeveral *nipples*, each of which is *perforated*, having their diameter correſponding with that of a ſmall grain of the duſt.

Being in the lower part of the chives, the minute grains are preſſed in them more and more by the ſtraitneſs of theſe pipes. They are therein moiſtened with a juice that lines their ſides. They open themſelves, and eject the *ſeminal vapour*, which penetrates to the ſeed, and promotes fecundation.

Several ſpecies of plants have two ſorts of individuals; *viz.* 1. Such individuals as only bear *ſta-*

mina, and theſe are *males*; and, 2. Individuals that have only the *piſtil*, which are *females*.

In a great number of other ſpecies, every individual is a real *hermaphrodite*, which unites both *ſexes*, the *ſtamina* and the *piſtil*. Sometimes this union happens in the ſame flower; then the *ſtamina* ſurround the *piſtil*. At other times it is only effected on the ſame *branch*; ſo that the *ſtamina* of ſuch are placed on one part, and the *piſtil* on another.

CHAP. XI.

The Fecundation of the Animal.

THE *ſeminal liquor* is the principle of *fecundation* in the *egg*. The *matrix* or ovaries are the places where it is performed.

Being incloſed in the *ſeminal veſſels*, the fecundating liquor appears in them, through a microſcope, like a maſs of ſmall regular bodies, of different lengths, which ſeem to ſeparate themſelves into a great number of extremely minute grains, moving different ways. Sometimes theſe corpuſcles reſemble caſes with ſprings, which, when moiſtened, open themſelves, and dart forth a limpid matter abounding with a great number of very ſmall grains.

The *matrix* conſiſts of three principal parts or dependencies; the *fundus* or bottom, the fallopian tubes, and the ovaries. The *fundus* contains one or more *cavities*, in which the *embryos* receive nouriſhment, and expand themſelves: it has an *orifice* in the fore-part. The fallopian tubes are conical pipes, or a kind of very long funnels, whoſe aperture is directed towards the *ovaries*, where it ends. The *ovaries* are a maſs of *veſicles* that are real *eggs*.

When

When the moſt ſubtile part of the ſeminal liquor has arrived through the fallopian tubes to the ovaries, it there fecundates one or more eggs. Theſe afterwards deſcend by theſe tubes into the matrix, where they are fixed, and unfold themſelves.

In *oviparous* females, the eggs are contained in a kind of bowel or *inteſtine*, wherein they receive their growth: the ſeminal liquor, which is diſpoſed in one or more cavities, makes them fruitful.

Moſt animals conſiſt of two ſorts of individuals; *male* and *female*. But there are other ſpecies, of which every individual is a real *hermaphrodite*, which unites the two, although it cannot fecundate itſelf.

In ſome ſpecies, where a diſtinction of ſexes is obſerved, there is no coupling, properly ſo called: the *male* only communicates his liquor to the eggs which the *female* has depoſited.

Finally, ſome ſpecies are propagated without any apparent or external fecundation.

CHAP. XII.

The Multiplication of the Plant.

A *Plant* does not only *multiply* by *ſeeds* and buds; it is likewiſe propagated by *ſuckers* and *ſprigs*. It may alſo be multiplied by *ſlips*, and by *engrafting*.

A tree ſends forth ſmall *buds* from various parts of its ſurface. Theſe buds increaſe in bulk; they open themſelves, and diſcloſe the *ſhoot*, which extends itſelf every day. While it is expanding itſelf, other ſtill ſmaller ſprigs ſhoot from it. Theſe in their turn are ſucceeded by leſſer ones; all of which are ſo many trees in miniature; and the nouriſhment received

ceived by one of theſe ſprigs is communicated to the whole plant.

When it has attained to a certain ſize, and is ſeparated from the trunk or principal ſtalk, either by nature or otherwiſe, theſe ſhoots will ſuſtain themſelves, and become ſo many diſtinct trees.

Being cut into pieces according to their width, or even their length, theſe ſhoots will grow again of themſelves, and will become as many trees as they were made ſlips of. The leaves themſelves, when ſeparated from their ſhoots, may afford ſo many complete plants.

Being faſtened cloſely to each other, or *inſerted* in one another, ſeveral of theſe ſhoots, whether taken from the ſame or from different individuals, will unite together in ſo intimate a manner, that they will receive reciprocal nouriſhment, and thus only form one individual whole.

CHAP. XIII.

The Multiplication of the Animal.

THE animal is not only *propagated* by *eggs* and living young, but likewiſe by *ſhoots*. It may alſo be multiplied by *ſlips*, and *ingrafting*.

A polypus ſends forth little *buds* from different parts of his body. Theſe buds grow big and lengthen inſenſibly. Every one of them is a young ſhoot. While it is unfolding itſelf, there ſpring from it other ſmaller ſhoots. Theſe in their turn produce ſmaller ſtill. All theſe ſhoots are ſo many little *polypuſes*, and the nouriſhment one of theſe *polypuſes* receives, is communicated to their whole number.

When they have arrived to a certain ſize, they ſeparate themſelves from the trunk or principal ſtalk, and become ſo many new individuals.

Being

Being cut into little bits, either tranſverſely or length-wiſe, the polypuſes grow up again from the ruins, and become as many complete ones as they were before made pieces by the ſection of them. The very ſkin, or even the leaſt fragment of them, is capable of affording one or ſeveral *polypuſes*.

CHAP. XIV.

Irregularities in the Generation of the Plant.

THE *generation* of *vegetables* is not liable to a conſtant regularity. The laws by which they operate are ſometimes infringed, or modified by different accidents. From them ariſe various ſpecies of *monſters* and mules.

Sometimes there are *compounded leaves*, whoſe ſmaller ones are more or leſs numerous, or more irregularly ſhaped, or diſtributed with leſs ſymmetry than uſual.

Sometimes there are flowers which have neither *ſtamina* nor *piſtil*, and whoſe *petals*, being greatly multiplied, ſeem to have abſorbed theſe eſſential parts.

Sometimes two fruits cleave together by a natural *graft*, or are incloſed in each other.

Sometimes there are *flowers* or *fruits* whoſe form differs widely from that which is peculiar to the ſpecies.

Laſtly, There are productions which do not properly belong to any particular ſpecies, becauſe they derive their original from ſeeds that have been fecundated by *duſt* of a different ſpecies.

CHAP.

CHAP. XV.

Irregularities in the Generation of Animals.

THE *generation* of *animals* is not always *regular*: the laws by which it is governed are ſometimes diſturbed or modified by various circumſtances; whence are produced the different ſpecies of *monſters* or *mules*.

Sometimes there are *hands* and *feet*, whoſe *fingers* or *toes* are fewer or more in number, or formed in a more irregular manner, or otherwiſe diſpoſed than uſual.

Sometimes there are *fœtuſes*, in which the *parts* of *generation* are obliterated.

Sometimes there are two *eggs* or two *fœtuſes* that cleave to each other by a natural coheſion, or that are contained in one another.

Sometimes there are *eggs* or *fœtuſes* whoſe form is greatly different from that which is peculiar to the ſpecies.

Laſtly, There are productions that partake of two ſpecies, becauſe they are produced from ſuch females as are fecundated by males of a different ſpecies.

CHAP. XVI.

Diſeaſes incident to Plants.

THE laws reſpecting the nutrition and growth of vegetables are liable to ſtill greater diſorders, or more frequent and varied modifications, than thoſe of generation. From hence are derived the different kinds of maladies the *plant* is ſubject to.

Some

Some of these *maladies* only attack the leaves, and produce on them *spots* of different colours, *wrinkles*, *pustules*, *scabs*, &c.

Others attack the principal *viscera*, and occasion *choakings*, *obstructions*, *stagnations*, *tumors*, *cancers*, *effusions*, &c.

Others take up their seat in the *flowers* or *fruit*.

Others affect *ligneous* bodies, which they cause to moulder away, whilst the bark remains whole.

Others come from little plants or divers insects, which, being on the outside or inside of vegetables, convert their nourishment to their own advantage, or change the organization of it.

Others derive their origin from a change of climate, aliment, culture, &c.

CHAP. XVII.

Diseases of the Animal.

THE laws of the nutrition and the growth of animals are more frequently and differently modified and disturbed than even those of generation. From hence proceed the various species of *disorders* to which an *animal* is exposed.

Among these maladies, there are some which attack only the *skin*, and produce *spots* of various colours, *wrinkles*, *pustules*, *pimples*, &c.

Others attack the principal bowels, and occasion *oppressions*, *obstructions*, *stagnations*, *tumors*, *abscesses*, *overflowings*, &c.

Others are seated in the *organs of generation*.

Others seize the bones, and beget *rottenness* in them, whilst the *periosteum* continues sound.

Others have their source in different insects, which, being lodged either without or within the animals,

animals, divert the nouriſhment of them to their own benefit, or alter the conſtitution of them.

Others are cauſed by the change of climate, nouriſhment, breeding, *&c.*

CHAP. XVIII.

Old Age and Death of the Plant.

FInally, the *plant*, after having eſcaped a variety of maladies which threatened its life, cannot elude the effects of *old age* that creeps into it, nor the ſtroke of *death*, the inevitable conſequence of it.

Beng hardened by time, the veſſels loſe their exerciſe, and are ſtuffed up. The liquors contained in them no longer move with the ſame facility, nor continue to be filtred and pumped out with the ſame preciſion. They ſtagnate and corrupt; and this corruption being ſoon communicated to the veſſels that incloſe them, the vital functions ceaſe to operate, the plant dies and crumbles into duſt.

CHAP. XIX.

Old Age and Death of the Animal.

LAſtly, the animal, after having been preſerved from thoſe diſeaſes which conſpired againſt him, cannot eſcape from melancholy *old age*, nor from inexorable death that follows in his train.

When the veſſels are grown hard through time, they loſe their action, and are ſtopped up. The liquors do not circulate in them with the ſame degree of quickneſs, and they are no longer filtred and pumped up but in a very imperfect manner. They ſtand

ſtand ſtill and are altered, and this alteration ſoon communicating itſelf to the veſſels that contain them, circulation ceaſes, the animal dies, and is reduced to duſt.

CHAP. XX.

Other Sources of Analogy between the Plant and Animal.

WE have carried the parallel between plants and animals from their birth to their death. The parts of which they conſiſt very evidently eſtabliſh the great analogy there is betwixt theſe two claſſes of organized bodies.

But there are other ſources of compariſons, which we have either avoided to dwell upon, that we might not render our deſcription confuſed, or have only ſlightly touched upon under certain points of view. Such are thoſe preſented to us by *place*, *number*, *fecundity*, *ſize*, *form*, *ſtructure*, *circulation of liquors*, *loco-motive faculty*, *feeling*, *nutrition*, &c.

We will take a tranſient ſurvey of theſe different ſources, and, without endeavouring to exhauſt them, content ourſelves with barely pointing out their moſt remarkable and characteriſtical contents.

CHAP. XXI.

Place.

VEgetables and animals reſide in the ſame dwelling-place. Being appointed to people and adorn our globe, they are diſperſed over its whole ſurface, and are placed near each other, in order to enable them to afford a reciprocal aſ-

ſiſtance.

ſiſtance. Like two great trees growing in the ſame ſoil, the animal and vegetable kingdoms intwine their branches together, and extend their boughs and roots to the extremity of the world.

The outſide and inſide of the earth, mountains and vallies, barren and fertile places, countries undiſcovered and hid in dark obſcurity, the regions of the north and ſouth, rivulets, rivers, ponds, lakes, and ſeas, have their vegetables and animals. The *ſwinebread* and *earth-worm*, the *maple* and *wild-goat*, the *birch-tree* and *hare*, the *ginſeng* and *ermine*, the *palm-tree* and *ape*, the *river-ſponge* and *leech*, the *water-lily* and *water-worm*, the *alga* and *cod*, are found in the ſame places, or live in the ſame element.

Many ſpecies of plants and animals ſeem to thrive alike in different climates. The *maronnier* and *turkey-cock*, when tranſported into theſe countries, appear to have forgot their native place.

Other ſpecies are *amphibious*, and live as well out of the water as in it. The *bulruſh* and *frog* flouriſh in meadows, and at the bottom of ponds.

Others are *paraſites*, and are nouriſhed by the juices they extract from different ſpecies. Such are the *miſſeltoe* and the *louſe*.

Laſtly, Some *paraſite* ſpecies ſupply their neceſſities, in their turn, from other paraſites. The *miſſeltoe* has his liverworts, and certain *lice* have their *lice*.

CHAP. XXII.

Number.

THERE are upwards of twenty thouſand ſpecies of plants known to us, and new diſcoveries of them made every day. A microſcopical botany has extended

extended the dominions of the ancient. *Moſſes*, *muſhrooms*, *liverworts*, whoſe families are innumerable, now take place amongſt vegetables, and preſent the curious with flowers and ſeeds which before they were unacquainted with, or had wrong conceptions of.

The microſcope at this time diſcovers plants to our view, where we never ſuſpected to have ſeen them. Free-ſtone is often covered with ſpots of different colours, commonly brown or blackiſh. Glaſs, notwithſtanding its fine poliſh, is not exempt from ſuch ſpots. We obſerve *hoarineſs* on almoſt all bodies. Theſe ſpots and this hoarineſs are found to be gardens, meadows, and foreſts in miniature, whoſe plants, that are infinitely ſmall, afford us nevertheleſs ſome proſpect of their flowers and ſeeds.

But although vegetables are very numerous in their ſpecies, yet they are much leſs ſo than animals. Every ſpecies of plant has not only its particular ſpecies of animals, but there are a great many ſpecies of plants which nouriſh ſeveral ſpecies of animals. The oak alone finds nouriſhment for above two hundred ſpecies of them. Some attack the *roots* of this tree, which they dig into, and produce therein various *tuberoſities*. Others fix themſelves in the *trunk*, where they make crooked furrows. Some inſinuate themſelves into the *bark* and *wood*; whilſt others penetrate the *interior* parts, whence they extract the juice. Some feed only on the *leaves*. Others *fold* or *roll* them up with a great deal of art. Some form them into *nuts*, whoſe ſize, colour, ſhape, and ſtructure, afford matter of ſpeculation to the naturaliſt. Others find both lodging and nouriſhment in the *fruit*. Nay, gather but a flower by chance, either a *daiſy*, *poppy*, or *roſe*, and you will obſerve on it a multitude

multitude of inſects, whoſe figure and motions will for ſome time attract your attention.

In ſhort, where can we turn our eyes without beholding animals? Nature has ſtrewed them everywhere with a bountiful hand. They were her moſt excellent productions; ſhe has been liberal of them. She has incloſed animals within animals; ſhe has ordained one animal to be a world for others, which ſhould find therein nouriſhment in proportion to their wants. The air, vegetable and animal liquors, corrupt matter, dirt, dung, dry wood, ſhells, and even ſtones, are all animated, all ſwarm with inhabitants. What do I ſay? The ſea itſelf ſometimes appears to be one intire collection of animals. The light, which glitteringly reflects on it in the night-time, during hot weather, is produced by an infinite number of very minute glow-worms of a yellowiſh-brown colour, and ſoft ſubſtance, not unlike caterpillars, every part of which, after being divided, and even putrified, ſhines with the ſame brightneſs as when the worm was whole and living. A ſpecies of *ſea-fleas* are alſo luminous, and communicate their luſtre to the waters. There iſſues from within them a globular matter, which is likewiſe phoſphorous.

Herbs are more numerous in their ſpecies and individuals than *ſhrubs* and *trees*. *Inſects* are more numerous, in reſpect to their ſpecies and individuals, than *birds* and *quadrupeds*. There are more *ranunculuſes* than *roſe-buſhes*, and more blades of *graſs* than *oaks*. There are more *butterflies* than *fowls*, and more *vine-fretters* than *dogs*.

CHAP.

CHAP. XXIII.

Fecundity.

THE magnificence of the creation ſhines in no part of it with greater luſtre, than in the prodigious fecundity of a great number of plants and animals. One ſingle individual may give birth to thouſands, or even millions of individuals like itſelf. Being formed agreeable to thoſe proportions which are only known to that ADORABLE WISDOM that has eſtabliſhed them, this great people was at firſt incloſed within the narrow compaſs of a rind or ovary. In this dark abode they receive their firſt life, begin to grow, and are diſpoſed to appear on the vaſt theatre of the viſible world.

If we conſider things in a general point of view, vegetables will be found to be more fruitful than animals. We ſhall be farther convinced of this, by comparing *trees* with quadrupeds.

Trees produce annually, ſometimes for many ages, and their productions are always very numerous. Large *quadrupeds*, as the *elephant*, the *mare*, the *hind*, the *cow*, *&c.* have ſeldom more than one at a time, very rarely two, and the number they breed is always very moderate. Leſſer *quadrupeds*, ſuch as the *dog*, the *hare*, the *cat*, the *rat*, *&c.* increaſe in a much greater degree; but their fecundity is but inconſiderable when compared to that of *ligneous plants*. The elm produces yearly upwards of three hundred thouſand ſeeds, and this aſtoniſhing multiplication may continue above a century.

Fiſhes and *inſects* very nearly reſemble vegetables in reſpect of their fecundity. A *tench* lays about ten thouſand eggs, a *carp* twenty thouſand, and a *melvel* or *cod* lays a million. An *inſect* which produces

duces the *itch* lays four or five thouſand eggs, a female *bee* forty-five or fifty thouſand.

To this amazing fecundity is oppoſed that of the *wild poppy*, *muſtard*, *fern*, *&c.* and we muſt not forget to remark, that moſt vegetables are propagated by different ways; whereas animals are for the moſt part propagated only by one.

A *tree* may be made to form as many trees as it has branches, boughs, and even leaves. Plants, which are principally deſigned to ſupply the neceſſities of animals, cannot be endued with too great a degree of fecundity.

CHAP. XXIV.

Size.

THE ſize of the greateſt *trees* is nearly equal to that of the largeſt animals. The bulk of the *elm* differs but little from that of the *whale*. But we do not find the ſame proportionable difference between the ſmall as the great. The ſmalleſt *microſcopic* plants exceed in bigneſs *animalcules* which are analogous to them. The diſtance is greater from the *whale* to the *animalcule* that ſwims in the infuſion of pepper, than it is from the *elm* to the ſmalleſt *hoarineſs*.

CHAP. XXV.

Form.

THERE is hardly any ſight more intereſting to a contemplator of nature, than that which the infinitely varied forms of plants and animals afford him. If he compares the leſs perfect ſpecies with thoſe

thoſe that are more perfect, or the ſpecies of the ſame claſs with each other, he is equally ſtruck with the diverſity of models by which *nature* has performed her works in the vegetable and animal kingdoms.

He paſſes with aſtoniſhment from the *ſwinebread* to the *ſenſitive*, from the *muſhroom* to the *carnation*, from the *agaric* to the *lilach*, from the *noſtock* to the *roſe-buſh*, from the *liverwort* to the *cherry-tree*, from the *hoarineſs* to the *cheſnut-tree*, from the *nightſhade* to the *oak*, from the *ſea-wrack* to the *linden-tree*, from the *miſletoe* to the *orange-tree*, from the *ivy* to the *fir-tree*.

He conſiders with ſurprize the prodigious multitudes of *muſhrooms* and *liverworts*, and can never enough admire the fecundity of nature in the production of theſe plants, ſo different from others in their form, and which he can hardly perſuade himſelf to rank amongſt the claſs of vegetables.

As he goes on to plants that are more elevated in the ſcale, he ſtops with pleaſure to examine thoſe plants that have *ſtalks*, from the graſs which grows between the ſtones to that precious plant, the ornament of our fields, whoſe *ear* furniſhes us with the moſt wholeſome and neceſſary food. He conſiders the various plants that *creep*, from the tender *bind-weed* to the *vine-branch* which crowns our hills, whoſe cluſters procure us a drink equally agreeable and ſalutary. He likewiſe takes a ſurvey of thoſe trees which bear fruit with *ſtones*, from the wild *plum-tree* to the *peach*, whoſe fruit does not excite our admiration more by the ſoftneſs of its velvet-covering and beautiful colour, than by the abundance and exquiſite taſte of the liquor it yields.

If from the vegetable our contemplator tranſports himſelf into the animal kingdom, the proſpect becomes ſtill more intereſting. He ſees oppoſed to

each other, in the ſame portrait, the *polypus* and *ſea-dog*, the *day-fly* and *flying-fiſh*, the *notonecti* and *duck*, the *demoiſelle*, or *dancing-bird*, and *eagle*, the *graſhopper* and *flying-ſquirrel*, the *ſpider* and *cat*, the *ant* and *ſtag*, the *cricket* and *rhinoceros*, the *wood-louſe* and *crocodile*, the *ſcorpion* and the *ape*.

Another picture preſents him with a view of the prodigious numbers of *butterflies* and *flies*; in conſidering which he is aſtoniſhed at NATURE's complaiſance in thus diverſifying theſe little animals, ſo different from the great ones by their forms, and which have been treated as defective or imperfect beings.

Transferring next his ſurvey to thoſe ſpecies of animals immediately higher, he contemplates *ſhell-fiſh*, from that whoſe precious liquor dyes the garments of kings, to the *ſailor* that rows with ſo much grace and ſkill on the inconſtant wave. He obſerves the different ſpecies of fiſh, from the dangerous *cramp-fiſh* to the powerful *nerval*, and from the pretty *golden-fiſh* of *China* to the *dolphin*, that cleaves the billow with the ſwiftneſs of a dart.

He likewiſe takes a review of thoſe *birds* that live on *herbs* or *ſeeds*, from the *linnet*, that delights us with his melody, to the *peacock* that pompouſly diſplays in our court-yards the gold and azure with which he is inriched. He alſo obſerves the birds of prey, from the fierce *merlin* to the *eagle*, whoſe ſtrength and courage have raiſed him to the ſovereignty over the birds. He next reviews the *quadrupeds*, from the light and timorous *hare* to the *elephant*, whoſe enormous corpulency attracts every eye; and from the wily *fox* to that noble and generous quadruped which ſeems formed to have dominion over the animal creation.

Plants, though they are prodigiouſly various in their forms, yet they are leſs ſo than animals. There

are

are fewer gradations from the *truffle* to the *ſenſitive*, or from the *nightſhade* to the *oak*, than there are from the *oyſter* to the *oſtrich*, or from the *ſea-nettle* to the *oran-outang*. Plants, being eſſentially more ſimple than animals, have not been able to give birth to ſo many combinations.

The forms of animals afford us a ſingularity which is extremely remarkable, and ſeem to furniſh us with a character ſufficient to enable us to diſtinguiſh them from vegetables; I mean thoſe admirable metamorphoſes which the ſame inſects exhibit to us under different aſpects, which are ſometimes ſo oppoſite, that it does not appear to be the ſame animal.

But may we not compare the bud in which a plant or flower is infolded, to the covering of a *chryſalis* which conceals the *butterfly* from our ſight? And as the plant cannot produce ſeeds till the flower has iſſued from the bud, ſo neither can the butterfly propagate till it has caſt off the ſheath of the *chryſalis*.

CHAP. XXVI.

The Structure.

IT is not ſo eaſy to compare plants and animals in their *interior forms* or *ſtructure*, as it is in their *exterior*. We may judge of the one by a ſingle glance of the eye: we muſt always beſtow a particular attention, and often require the aſſiſtance of divers inſtruments, to enable us to judge of the other. We penetrate, methinks, with greater difficulty, into the inſide of a plant, than into that of an animal. There every thing appears more mixed, more uniform, finer, and more animated: here

every thing ſeems more diſtinct, either becauſe the form, texture, colour, and ſituation of the different parts, exhibit a greater variety, or becauſe the exerciſe of the principal *viſcera* is always in them either more or leſs ſenſible. The microſcope, ſcalpel, and injections, which are ſo very ſerviceable to us in the anatomy of animals, are frequently of no uſe to us, or at leaſt aſſiſt us but very imperfectly in that of plants. It is likewiſe true, that this part of organical œconomy has been leſs ſtudied than that which has animals for its object. The ſtructure of theſe laſt has the more intereſted us, by reaſon of their relations to that of our own body.

But how imperfect ſoever the anatomy of plants may at preſent be, we are enabled notwithſtanding to diſcover ſome of their principal veſſels, and trace their ramifications to a certain degree. Theſe veſſels may be ranged under two general claſſes; the *longitudinal* veſſels, or thoſe that extend the whole length of the plant; and the *tranſverſe* veſſels, or ſuch as are placed acroſs it.

The *ſappy* veſſels and *trachæan* belong to the firſt claſs; the *utriculi* or *inſertions* are compriſed under the ſecond.

The veſſels containing the ſap ſeem principally deſigned to convey the juice. The *utriculi*, or little bags, appear to be peculiarly intended for preparing and digeſting it. Theſe are a kind of ſtomach, as I have already inſinuated.

Some plants ſeem to be intirely compoſed of *utriculi*: ſuch are certain ſpecies of *roots* and *ſea-plants*, whoſe texture is almoſt altogether *parenchymatous*, or veſicular. It is the ſame with thoſe animals which ſeem to conſiſt of ſtomach only, as the *polypus* and *tænia* or tape-worm.

One of the principal characters by which we may diſtinguiſh inſects from large animals, is, that the former

former have no *bone* within them. What they have of a bony or ſcaly nature is placed on their outſide for a ſupport or defence to the more delicate parts underneath, or to ſuſtain the body with greater advantage. Thus we ſee that in almoſt all inſects, *properly ſo called* †, the head, corſlet, legs, rings, *&c.* are either wholly, or for the moſt part doubly covered with ſcales.

Herbs differ chiefly from *trees* by an analogous character. They have no *ligneous body* in their center. What they have of a ligneous, or at leaſt an herbaceous nature, appears on the outſide, and ſerves to protect the weaker parts, or to fortify the body of the plant. Thus we find plants with *tubes* are ſtrengthened by knots placed at regular diſtances; ſo that the lowermoſt knots, which are deſigned for the baſe, are ſtronger and nearer each other than the upper ones. It is on the ſame account that the roots of many herbaceous plants, as well as the *calixes* of flowers, and the capſules or coverings of the ſeeds, are made almoſt ligneous.

Herbs grow and become hard ſooner than *trees*. *Inſects* grow and harden quicker than great animals. Herbs and inſects, being of a ſofter conſiſtence than trees and large animals, conſequently extend themſelves with greater eaſe, and ſooner arrive at the period of their extenſion. Beſides, the concentric beds of the bark of trees, and thoſe of the *perioſteum* of animals, being far more numerous than the relative beds of herbs and inſects, muſt needs require a longer time for their growth.

We may diſtinguiſh two kinds of parts in organized bodies; to wit, *ſimilar* and *diſſimilar*. The former are compoſed of fibres of the ſame kind; the latter are formed of fibres of various ſorts. The

† Part III. Chap. 17.

nerves, arteries, veins, lymphatic veſſels, *&c.* are the *ſimilar* parts of our bodies; the brain, heart, lungs, ſtomach, *&c.* are the *diſſimilar*. Plants are almoſt intirely compoſed of *ſimilar parts*. The veſſels containing the ſap, the *trachææ*, and *utriculi*, are of this kind. Theſe different veſſels are pretty uniformly diſperſed throughout the whole body of the plant: they enter into the compoſition of all its parts. They are to be met with in the root, ſtalk, branches, leaves, flowers, and fruits. The leaſt fragment, the ſmalleſt leaf, is a repreſentation of the whole, an abridgment of the plant.

There are likewiſe animals which are nearly compoſed altogether of *ſimilar* parts. Of this number are many ſpecies of long worms without legs, and ſome *aquatic millepedes*, *nettles*, and *ſea-ſtars*, *polypuſes*, *moths*, *earth-worms*, *&c.* All theſe animals are formed in ſuch a manner, that each part of them, even the ſmalleſt, correſponds in miniature to the whole in all its parts.

In the *long worms* I juſt mentioned, we obſerve very diſtinctly a ſtomach, an heart, and ſome very ſmall veſſels which ſeem dependent on the latter. There is likewiſe no room to doubt that there is beneath the ſtomach a *medullary* ſtring, like that obſerved in other ſpecies of worms and caterpillars. Their *viſcera* are not diſtributed into certain regions of the body; they are univerſally diſperſed throughout its whole length; ſo that we may truly affirm that theſe inſects are all brain, all ſtomach, all heart. But this brain, ſtomach, and heart, appear extremely ſimple; the firſt is ſcarce any thing more than a nervous piece of net-work, the ſecond a membranous bag, and the third a grand artery.

Polypuſes, which are more ſimple in their ſtructure, are only a kind of bowel, ſown with an infinite number of ſmall ſeeds, which are tinged with

the colour of the aliment. This bowel may be turned inside out like a stocking, without appearing to affect the animal thereby.

Tape-worms partake of the structure of polypuses, but seem to be more compounded. They are formed of a chain of flat, membranous, and whitish rings, and jointed together like the divisions of a reed. Each ring has on its upper part, or on one of its sides, a more or less sensible eminence, in the center of which is a small round aperture. The middle of the ring is full of vessels of a purple or whitish colour, which perform a labour that attracts the attention of the observer. The rest of the ring is filled with an infinite number of small white seeds. Such is essentially the structure of the tape-worm in its whole extent; there is no perfect variety or resemblance between all the rings, the assemblage of which composes a kind of ribband or lace, which extends sometimes several hundred feet in length.

Earth-worms are, of all the insects I have mentioned, those whose inside seems to be the most compounded, chiefly because in them the two sexes are united: but the most essential organs of life are distributed in them likewise through the whole length of the animal.

Organized bodies, whose structure is so simple and uniform that each part of them has in a small compass an organization resembling that of the whole in a greater extent, enjoy divers prerogatives that have been denied to organized bodies of a more refined and complicated structure. The first of these are not destroyed when divided or parted asunder. Their different portions continue to live, and the wounds which have been given to them easily consolidate. These parts vegetate, receive nourishment, produce new organs, and multiply. Such wonders

as theſe the vegetables and inſects we have lately treated of exhibit every day to our view: wonders which we have not ſufficiently admired in the former, and which perhaps we too much admire in the latter.

Large animals do not furniſh us with the ſame *phænomena*. The conſolidation of their wounds, and the re-union of their fractures, although oftentimes attended with circumſtances which render them very remarkable, ſtrike us but ſlightly when compared with what we obſerve analogous in polypuſes, and other inſects that multiply by ſlips. The motions we perceive in certain parts of great animals, when ſeparated from the body, or after the death of the animal, affect us only with a ſlender degree of ſurprize, when we conſider the motions of different parts of worms, or thoſe of ſome *millepedes*.

But may there not be ſome miſconception in theſe different judgments? We judge of the effect produced, as conſidered in itſelf, and ſeparate from the circumſtances accompanying it; whereas we ſhould judge of it with relation to the greater or leſs degree of compoſition whereof the body, in which this effect is produced, conſiſts. There is as much, and indeed more to be admired in the conſolidation of certain wounds, or in the re-union of certain fractures of our body, than there is in the conſolidation of the wounds of polypuſes, or in the re-union of parts which have been ſeparated from them. A very ſimple machine is eaſily repaired; a machine that is extremely compounded, cannot be repaired with the ſame facility. When we reflect on the prodigious number of ſimilar and diſſimilar parts contained in the compoſition of the bodies of great animals, and particularly in that of the human body; when we attend to the ſtrict connection of all theſe parts, and to the degrees of compoſition in each of them,

them, we cannot ſufficiently wonder that the various accidents which happen to theſe bodies are not attended with greater conſequences; we ſhall at the ſame time perceive the reaſon why they are not enabled to propagate like bodies whoſe organization is more ſimple.

But independently of the greater or leſs degree of the compoſition of parts neceſſary to life, as ſoon as theſe parts are found placed in different regions of a body, and are not diſperſed throughout its whole length, ſuch a body cannot be multiplied by ſlips. The AUTHOR OF NATURE, by denying, in his wiſdom, this property to large animals, by confining the ſources of life in them within a narrow circle, has ſecured them from harm by many advantages. Compare the reſult of the motions or actions of a ſea-worm with that of the motions or actions of an ape, and you will ſoon perceive which of theſe animals has been moſt favoured.

Finally, organized bodies, to which a power has been granted of multiplying by a method which ſeems to tend to their deſtruction, are ſuch as are expoſed to the greateſt dangers, and whoſe life is neceſſarily threatened every moment with a thouſand various accidents.

CHAP. XXVII.

The Circulation.

AMongſt the motions we obſerve within-ſide the animal machines, that of the circulation holds the firſt rank, either by its importance, or its nature, duration, and the number of organs by means whereof it is performed. There is in this motion an air of grandeur that ſeizes forciby on the mind, and

which, by making it ſenſible of the narrow limits of human underſtanding, penetrates it with moſt profound reſpect, and fills it with the higheſt admiration of the INFINITE MIND which illuſtriouſly ſhines in the DIVINE AUTHOR of it.

In the centre of the breaſt, between two ſpongy or vaſcular maſſes known by the name of lungs, is depoſited a fleſhy pyramid, whoſe baſe bears two ſmall funnels like ear-rings, which communicate with two cavities contained in the inſide of the pyramids and which divides it according to its length into two chambers or *ventricles*, the *right* ventricle and the *left*. This pyramid is the *heart*, or the main ſpring of the machine. It has two principal orders of *muſcular fibres*; ſome of which paſs obliquely from the baſe to the point, others cut the latter tranſverſely. From the exerciſe of theſe fibres two oppoſite motions reſult; one of ſhortening or *dilatation*; the other of extenſion or *contraction*. The heart ſeems to execute theſe motions by turning on itſelf like a ſcrew. Its point moves towards or from the baſe, by riſing or falling obliquely.

Two great veſſels, *viz.* an artery and a vein, communicate with each ventricle. The artery †, which communicates with the right ventricle, conveys the blood to the lungs. The vein ‡, which communicates with the ſame ventricle, forms the principal trunk of the veins, and carries back the blood from all parts to the heart. The artery *, which goes into the left ventricle, is the chief trunk of the arteries, and that which conveys the blood to all parts. The vein ‖, which ends at the ſame ventricle, tranſmits to it the blood that has been conveyed from the lungs.

† The pulmonary artery. ‡ The *vena cava*. * The grand artery, or the *aorta*. ‖ The pulmonary vein.

The

The principal trunks of veins and arteries are divided into ſeveral branches at a ſmall diſtance from the heart. Some tend towards the upper extremities, others towards the inferior.

The arteries and veins decreaſe in diameter, and are ramified more or leſs according to their diſtance from their origin. There is no part to which theſe do not diſtribute one or more ramifications.

When they have arrived at the moſt remote parts, the arteries have an intercourſe with the veins, whether this intercourſe be real or immediate, or whether it be effected by the interpoſition of a very fine web, or that the ſame veſſel is extended like a ſyphon with two branches.

The arteries are compoſed of ſeveral principal membranes, placed on each other, and which give motion and feeling to them. The veins have ſimilar membranes, but they are in them more ſlender or weaker. The veins were not deſigned to exerciſe the ſame power as the arteries. Theſe latter muſt neceſſarily, like the heart, and for the ſame end, dilate and contract themſelves; they have therefore been provided with a very elaſtic membrane. The exerciſe of the veins ſhould not be violent.

At the root of the arteries, and in the inner part of the veins, are placed little ſluices or valves, which by ſinking and riſing again open and ſhut the canal. Theſe valves are depoſited in the veins, in a contrary ſenſe from that for which they are in the arteries. We ſhall preſently account for the real cauſe of this difference.

After having been maſticated and diſſolved in the mouth and ſtomach, the aliment deſcends into the inteſtines, where it receives a new preparation by the mixture of two liquors, one of which is furniſhed by the liver, and is called the bile; and the

other by a ſpecies of gland * ſituated under the ſtomach.

The aliment is thus converted into a kind of greyiſh pulp, which has received the name of *chyle*. Being ſhifted from place to place by the vermicular or *periſtaltic* † motion of the inteſtines, and ſtrongly preſſed againſt their ſides at the inſtant of their contraction, the chyle penetrates into extreme ſmall veſſels ‡, which open themſelves in the internal membrane of the inteſtinal canal. Theſe veſſels tranſmit the chyle to very ſmall glands which are covered with a kind of membrane ‖ ſituated in the midſt of the inteſtines, and round which they are in a manner rolled. After being filtred and worked in theſe glands, the chyle is from thence received by other veſſels **, which convey it into a concavity †† placed along the ſpine, and which pours it into a vein ſituated under the left clavicle. There it enters into the blood, and loſes the name of *chyle*. From this vein the new blood paſſes into the upper branch of the principal trunk of veins, which carries it towards the heart. It paſſes into the right lobe, which opens at its approach, and, by cloſing immediately, forces it into the right ventricle, which is dilated in order to receive it. The heart inſtantly contracts itſelf; the valves, with which the ventricle is furniſhed, raiſing themſelves to oppoſe the reflux of the blood into the lobe, it is compelled to paſs the artery, which is appointed to carry it to the lungs. The valves, which are placed at the entrance of this artery, ſink down; the artery dilates, and the blood advances into the cavity. The valves riſe again, and prevent its return towards the heart.

* The *pancreas* AND *pancreatic* juice. † See chap. 3. of part vii. ‡ The *primary lacteal* veins. ‖ The *meſentery* and *meſenteric* glands. ** The *ſecondary lacteal* veins. †† The *thoracic duct*.

The

The artery contracting itſelf, the blood is impelled farther, and, by theſe alternate dilatations and contractions of the veſſel, it is conveyed to the lungs, where it runs through every part of them. The ramifications of the *trachea* *, which are diſperſed in the *viſcera*, carry thither a freſh and elaſtic air, which, by acting on the ſluggiſh and ſpongy maſs of the lungs, dilates, winds them about, extends, and opens them, and by that means facilitates the courſe of the blood into the ſmalleſt ramifications of the artery. Beſides, being impregnated with this air, the blood becomes thereby attenuated, is cooled, and receives a more lively colour. After its arrival at the extremities of the artery, it paſſes into that of the *pulmonary* vein, which conducts it to the left ventricle of the heart. This latter, by contracting itſelf, puſhes it into the *aorta* †, which, by continually dividing and ſubdividing itſelf, diſtributes this balſamic liquor to all the parts, in order to promote their growth or ſupport, and occaſion different *ſecretions*. ‡ The valves of the *aorta*——but my reader has already anticipated me. From the extremities of this artery the blood paſſes into that of the *vena cava* ‖, which tranſmits the reſidue of the blood to the heart, in order to cauſe it to enter afreſh into the channels of *circulation*. By this method the powerful energy of the heart, ſeconded by that of the arteries, tranſmits the blood to the moſt remote parts of the body, notwithſtanding the reſiſtance which gravity, frictions, and a thouſand other circumſtances make to it in its courſe. The ſtrong and continual preſſure of the *arterial* blood on the *veinous*, ſo as even to ſurmount its natural weight, forces it to riſe from the lower parts to the heart.

* The *bronchia*. † The principal trunk of arteries. ‡ See ch. 5. part vii. ‖ The principal trunk of veins.

Thoſe kinds of valves which are diſtributed here and there within the aſcending veins, and which are like little ſteps, the conſtant beating of the arteries on their ſides, the exerciſe of the muſcles, *&c.* contribute ſtill more to promote the return of the blood.

Such is, though in a very narrow compaſs, the admirable mechaniſm of the circulation of the blood in men, and in thoſe animals which we are beſt acquainted with. But how greatly does this imperfect ſketch fall ſhort of the reality! How incapable are theſe outlines of expreſſing the beauties of this noble ſubject! How do I envy, ye phyſicians, your ſuperior knowledge, who are more intimately verſed in theſe beauties, who are able more clearly to diſcern this wonderful œconomy, and who have made an exact calculation of the action of thoſe powers which preſerve life and motion within us! But what are thoſe excellent diſcoveries hitherto made by you, compared with the beauties that are ſtill concealed from you! What are your learned and curious deſcriptions, with regard to the merit of the ſubject itſelf! Thoſe rude figures inſcribed on the wall by the hand of a child, do not perhaps ſo widely differ from the moſt finiſhed performances of a *Rubens* or a *Le Brun*. Can you diſtinctly account for the manner by which the ſtrength of life is repaired and recruited? Do you clearly conceive the cauſe of that perpetual motion of the heart, which continues without intermiſſion for the ſpace of ſeventy, eighty, or an hundred years, which has laſted for ages in the firſt race of men, and which indeed remains almoſt as long in ſome ſpecies of animals? Have you diſcovered the exact part where the artery is changed into a vein? Have you diſcloſed the myſtery of the ſecretion of thoſe ſpirits, whoſe prodigious ſubtilty and activity ſeem to give them a near reſemblance to light? Can you even determine in what manner the groſſeſt

ſecretions

ſecretions are performed? Do you underſtand the true mechaniſm of muſcular motion? Have you been able to find out the ſource of that great ſtrength which often ſo far exceeds that of the heart? All theſe dependencies on circulation are yet unrevealed to us. The gloom of night ſtill wraps theſe regions in dark obſcurity, and you are earneſtly deſirous of chaſing it away from before that ſun which alone can diſpel theſe ſhades. Will the dawn of that day ere long gild the horizon of the learned world? Or is the time of its breaking forth upon us yet afar off?

But if we are not able to diſcover the whole, we may at leaſt ſee enough of it to excite our admiration; and the ſketch which I have juſt drawn of the circulation, is ſufficient to enable us to conceive the higheſt ideas of the SOVEREIGN MIND which has appointed the manner, duration, and end of it.

Far leſs magnificent in its plans, leſs ſkilful in the execution of them, hydraulics offer to us but faint images of this miracle, in thoſe machines by means of which water is raiſed above the mountains, in order to its being diſtributed into every quarter of a great city, and made to circulate and iſſue forth, under a hundred various forms, into thoſe gardens which art and nature vie with each other in adorning and embelliſhing.

The works of the CREATOR muſt be compared with the works of the CREATOR. Ever like HIMSELF, HE has impreſſed on all HIS productions a character of nobleneſs and excellence, which demonſtrates the grandeur of their origin. From that immenſe maſs of water which encompaſſes the great continents, there inceſſantly ariſes an ocean of vapours, which, being rarefied by the combined action of the ſun and air, ſpread themſelves in the upper regions of the atmoſphere, where they remain ſuſpended

pended *in equilibrio*, being intermixed with the fluid in which they float, and gravitate with it. Collected afterwards into clouds more or less dense, and borne on the wings of the winds, they fly cross the celestial plains, which they adorn with their rich colours and continually variegated forms. Fixed at length on the mountain tops, they pour upon them abundant rains, which being collected in the vast reservoirs embosomed within them, furnish, by a happy circulation, a supply to fountains, rivers, lakes, and seas. Like veins and arteries, the rivers flow meandring and branching on the surface of the earth; they run through immense countries; water, fertilize, and unite them by a reciprocal commerce, and, majestically rolling their waves towards the sea, plunge themselves into it, in order to be again exhaled in vapours, and re-enter afresh into the channels of this magnificent circulation.

CHAP. XXVIII.

Continuation of the same Subject.

DOES the sap *circulate* in plants as the blood circulates in animals? Is this new mark of analogy between these two classes of organized bodies as real as it has appeared to be?

Small bladders full of air which have been thought to be discovered within the leaves, the numberless ramifications and intwinings of their vessels, have convinced us that they were the *lungs* of the plant. It has been conjectured, that the sap rises, through the fibres of the wood, in order there to receive different preparations, and that it descends, by the fibres of the bark, from the leaves to the roots, to be from thence distributed into all the parts. This ingenious

genious hypotheſis has been attempted to be maintained by many facts, but all of them ſo equivocal, that it were much better to omit them, and only indicate the oppoſite reaſons, which are much more convincing.

If the ſap riſes from the roots to the leaves by the fibres of the wood, if it deſcends from the leaves to the roots by the fibres of the bark, the upper extremity of trees ſhould be moiſtened in the ſpring before the lower. Notwithſtanding which, we obſerve the contrary. Trees, whoſe *ligneous body* is deſtroyed, ſtill continue to vegetate. There have not been diſcovered in plants veſſels analogous to veins and arteries. No organ has been ſeen in them, capable of performing the functions of the heart. A tree which is planted a contrary way, with the roots a-top and the branches in the ground, lives, grows, bears fruit; from its roots branches ſhoot forth, from its branches roots. The ſame is obſerved with reſpect to ſlips and layers. A young branch, or young fruit, after being grafted on a ſubject foreign to itſelf, incorporates with it, and derives from thence the ſame degree of growth it would have received from the plant whence it was detached. Experiments made by a very ſkilful hand demonſtrate, that the motion of the ſap depends intirely on the alternatives of heat and cold, and the viciſſitudes of day and night. It is evident from theſe experiments, that this motion is progreſſive in the day-time, and retrograde during the night; that the ſap riſes in the day from the roots to the leaves, and falls in the night from the leaves to the roots. We ſee that this liquor raiſes, in the day-time, the mercury contained in a glaſs-tube applied to a branch that vegetates, and lets it fall again when night approaches. In a word, the courſe of the ſap nearly reſembles that of the liquor contained in the tube

of

of a thermometer. All is reduced to a ſimple counterpoiſe.

The opinion concerning the circulation of the ſap in plants, which has been formerly ſo much adopted, is at preſent greatly ſuſpected of falſity, to ſay no more of it. Thoſe who have endeavoured to eſtabliſh it, ſeem to have been more ſtruck with the beauty of the ſuppoſition than with its uſe; or rather, they have not ſufficiently conſidered, that *utility* is the true meaſure of *beauty*. The nouriſhment of the more perfect animals requires to be more wrought than that of plants, proportionably to the excellence of the former, and the perfection of the latter. Hence the neceſſity of the *circulation of the blood*. The preparations of the ſap do not require ſuch a punctual, regular, and conſtant motion: bare poiſings ſuffice. Large animals eat but at particular times: a quick and preſſing ſenſation which induces them to take nouriſhment, does not continually act upon them. The different preparations their aliment ſhould undergo, would be diſturbed or interrupted, were a freſh ſupply to be received within them before the former was ſufficiently digeſted.

Plants, on the contrary, are in a ſtate of perpetual ſuction; they draw in nouriſhment continually, and in a very great quantity, in the day-time by their roots, in the night by their leaves. There is a plant which receives and tranſpires, in the ſpace of twenty-four hours, twenty times more than a man.

But if plants differ ſo much from large animals by circulation, on the other hand ſome ſpecies of animals ſeem nearly to reſemble plants by their want of this circulation. Not the leaſt appearance of this motion is to be perceived in the *polypus*, the *tape-worm*, the *pond-muſcle*, and divers other ſhell-fiſh.

I have ſeveral times had occaſion to mention the *pond-muſcle*. There is ſomething very remarkable in

in its ſtructure. It takes in nouriſhment and breathes by the *anus* only. It has, properly ſpeaking, no brain. What is commonly taken for the head, is an aperture, which may be conſidered as the mouth of the animal. It has a kind of heart, furniſhed with a ventricle and two lobes. On a particular motion of the muſcle the *anus* opens, and tranſmits the nouriſhment to certain pipes which lead to the mouth. This nouriſhment ſeldom conſiſts of any thing but water. At the bottom of the mouth are ſeen two other pipes; one of which terminates at the heart; the other paſſes by the brain, and by a ſort of bowel, which ſeems analogous to a liver, but which is not more a liver, than that which is termed a brain is a real brain. The water which the mouth conveys to the heart by the canal of communication, falls from the ventricle into the lobes, and returns from thence back again into the ventricle. To this the whole ſyſtem of the circulation in pond-muſcles may be reduced. Not the leaſt veſtige of veins or arteries. How imperfect is this deſcription of the circulation! It is indeed a mere image of it; for the bare moving of a nutritious liquor can never be a circulation properly ſo called.

Thus phyſicians, who, for the ſake of beauty and harmony, have advanced that the ſap circulates in plants as the blood circulates in great animals, have had very imperfect notions of the ſyſtem of the world, and of the variety of the productions of nature. The ſcale of organized bodies is much more extenſive than they ſeemed to think. On the inferior degrees of this ſcale we ſee organized bodies whoſe liquors ſimply flow from the bottom to the top, and from the top to the bottom. A little higher we perceive other bodies whoſe liquors are agitated in a different manner. If we go higher ſtill, we ſhall diſcover a beginning of circulation, but whoſe

whoſe efficient cauſe may be chiefly reduced to one or two great veſſels. This apparatus becomes more compounded in the higher degrees of the ſcale; at firſt it is a heart of an ordinary form, but which has only one lobe: afterwards there are two lobes, and a much greater variety of organs and veſſels.

CHAP. XXIX.

The loco-motive Faculty.

ONE of the ancients defined a plant to be a rooted animal. He would undoubtedly have defined the animal to be a wandering plant. The loco-motive faculty is in effect one of thoſe characters which preſent themſelves firſt to the mind when we compare the vegetable kingdom with the animal. We ſee plants that are conſtantly fixed to the earth. Being incapable of ſeeking their nouriſhment, it is ordained that this nouriſhment ſhall ſeek them. And although ſome aquatic plants ſeem to tranſport themſelves from one place to another, it is not effected by any motion peculiar to them, but by that of the fluid in which they are ſuſpended. 'Tis for the moſt part by ſuch means that different kinds of ſeeds flutter about in the air by the aſſiſtance of little wings which they are provided with, and are ſometimes carried into very remote parts, to propagate the ſpecies there.

The greateſt part of animals, on the contrary, are ſubjected to the care of providing their own ſubſiſtence. *Nature* has not always depoſited near them ſuch nouriſhment as was neceſſary for their ſupport. *She* has thought proper to oblige them to procure it for themſelves, and oftentimes with much labour and induſtry. And the different methods by which

which ſhe has inſtructed each ſpecies to attain this end, are not what tends the leaſt to diverſify the ſcene of our world.

Whilſt the plowman opens the boſom of the earth, in order to intruſt with it the ſeeds neceſſary to ſupport him and repair his ſtrength, the mole and mole-cricket are clearing for themſelves different routes, in the ſame boſom, to ſearch for the food allotted to them. The indefatigable huntſman purſues his prey with an obſtinate reſolution: he pierces it with inviſible arrows, triumphing thus in his ſwiftneſs and ſtrength. At other times preferring craft to open force, he becomes maſter of it by laying ſnares for it. The fierce tyger ruſhes on the fawn that is ſporting in the meadow. The wily cat watches motionleſs and ſilent, till the young mouſe iſſues forth from its retreat, that ſhe may dart upon it in a moment, or ſkilfully intercept its way. The cruel waſp faſtens on the laborious bee, on her return laden with honey to the hive, well knowing how to extract from her bowels the delicious liquor which ſhe is ſo fond of amaſſing. The ſpider, equally cunning and patient, ſpreads a net for the fly, whoſe ſtructure and fineneſs is admirable. The lion-piſmire, not inferior either in patience or induſtry, digs a precipice in the ſand for the ant, at the bottom of which he lies in ambuſh for him. Some ſpecies of animals, reſembling mankind in a great meaſure by their prudence, have the ſagacity to lay up proviſions againſt a time of ſcarcity; build themſelves magazines, in which are every-where obſerved ſuch juſt and ſometimes geometrical proportions, as to give us good cauſe to doubt whether it was the workmanſhip of a brute, were we not convinced that this brute itſelf is the work of SOVEREIGN REASON.

How

How great the diſtance is in this reſpect from the beaver and bee to the gall or cochineal-inſect, the oiſter, the ſea-nettle, and ſeveral other kinds of inſects and ſhell-fiſh? The gall-inſect*, being confounded by his immobility and form with the tree on which he lives, contents himſelf with extracting its juice; there is not the leaſt appearance of an animal in it; and a perſon muſt inſpect it very cloſely, and with a clear and penetrating ſight, before he can be convinced that it is not a real gall-nut. Carried by the wave to the ſea-ſhore, the oiſter remains fixed there, and all its motions conſiſt in opening and cloſing his ſhell. The ſea-nettle, and all the different polypuſes with *pipes*, may and have in fact been taken for productions of the vegetable world: being continually fixed to the ſame place, they open and ſhut like a flower; they extend and contract themſelves like a ſenſitive plant; they ſtretch out ſpecies of arms, by means of which they ſeize ſuch inſects as chance brings within their reach. This is their principal character, and the leaſt equivocal character of their *animality*.

Thus it appears that the *loco-motive* faculty is not more proper for diſtinguiſhing the vegetable from the animal, than thoſe other characters are which we have before treated of. Theſe are every-where only properties or common accidents, without any real difference. In the mean time, what can be more diſtinct in appearance than a plant is from an animal? or what more eaſy to characterize in the ſight of the major part of mankind? But when once we are convinced that every thing in nature is ſhadowed over, we are not ſurpriſed at the difficulties we meet with in our attempts to diſtinguiſh beings. We neceſſarily expect to ſee the ſpecies enter again

* See chap. 7. of part viii.

into each other; and confine ourſelves to the ſmalleſt latitude, or to that which is attended with the leaſt uncertainty. In this principle we will conclude the parallel we have undertaken: let us ſee whether feeling, and the manner by which animals and vegetables are nouriſhed, will furniſh us with any thing more preciſe or characteriſtical.

CHAP. XXX.

Feeling.

IF there be any faculty which ſeems peculiar to the animal, excluſively of the plant, it is certainly that of being *animal*, I mean of being endued with a ſoul capable of *feeling*. Being united to an organized ſubſtance by ties which perhaps are known to GOD only, this ſoul compoſes with this ſubſtance a *mixed* being, a being which partakes of the nature of bodies and of that of ſpirits. As a portion of matter, this being is a machine which is admirable in its ſtructure, and on which corporeal objects act in a manner abſolutely mechanical. As a ſpiritual ſubſtance, this being is affected at the preſence of ſpiritual objects in a manner which does not ſeem to have any relation with that by which material ſubſtances act on each other. From the impreſſion of external objects on the machine, there reſults a certain motion in the machine. From this motion there follows a certain ſenſation in the ſoul, which is ſucceeded by the reaction of the ſpiritual ſubſtance on the corporeal; a reaction which manifeſts feeling from without, and which is the expreſſion or *ſign* of it.

The various ſenſations which are excited in the animal may be reduced to theſe two general claſſes, *pleaſure*

pleaſure and *pain*, ſeparated from each other by degrees which are frequently inſenſible, and iſſuing from the ſame origin. Pleaſure prompts the animal to ſeek for that which is conducive to its preſervation, or to that of the ſpecies. Pain urges it to fly every thing that is incompatible or hurtful to theſe ends. The expreſſion of pleaſure and pain is not alike in all animals; either becauſe the intenſeneſs or quantity of pleaſure and pain varies in different ſpecies; or becauſe the organs, by means whereof the ſoul manifeſts her ſentiments, are not the ſame in all animals.

There are ſpecies in which feeling is manifeſted by a greater number of ſigns; by more varied, more expreſſive, leſs equivocal ſigns; and thoſe ſpecies are the moſt perfect, which have the neareſt relations with us. What expreſſion, for inſtance, is there in the air, the motions, and the various attitudes of an ape, an horſe, a dog, a cat, or a ſquirrel?

There is not much leſs expreſſion in birds than in quadrupeds. In order to be convinced of this, we need only caſt our eyes on a poultry-yard: but birds of prey are perhaps ſtill more expreſſive than domeſtic birds.

Fiſhes do not expreſs themſelves with the ſame clearneſs and energy; they form a dumb people, amongſt whom the language by ſigns is little practiſed; but the extreme vivacity of their motions ſeems in part to compenſate for their ſterility of expreſſion.

Reptiles, ſhell-fiſh, and inſects, which are ſtill at a greater diſtance from us than fiſhes, expreſs to us their feelings in a more obſcure manner; but which, notwithſtanding, we can conceive to a certain degree, and often think proper to acknowledge to be very expreſſive.

Laſtly

Laſtly, Thoſe animals which are leſs than all others, ſea-nettles and polypuſes, exhibit to us marks of feeling which we cannot deny, when we obſerve them with ſome attention. The quickneſs of their contracting themſelves immediately after having been touched, though but very ſlightly, the manner of their extending and ſhortening their arms, in order to ſeize their prey, and carry it to their mouth, will not admit of our excluding them from the number of ſenſible beings.

On the contrary, we do not diſcover in the plant any ſign of feeling. All in that ſeems to be purely mechanical. Its life appears to be leſs a life than a ſimple duration. We cultivate a plant, or we deſtroy it, without experiencing any thing ſimilar to what we meet with when we cheriſh an animal, or put it to death. We ſee the plant ſhoot forth, grow, flouriſh, and bud, as we perceive the hand of a clock to have paſſed over all the points of the dial by an inſenſible motion.

The plant does not only appear inanimate, conſidered externally, or in the courſe of its actions; but it likewiſe ſeems ſo if conſidered internally, or in its ſtructure. The fineſt and moſt elaborate anatomy does not diſcover to us any organ therein which may be ſaid to be analogous to thoſe which are the ſeat of ſenſation in the ſoul

Theſe are the different conſiderations which may lead us to conſider *feeling*, or the *organ* of feeling, as a character proper for diſtinguiſhing the vegetable from the animal. But there is ſtill room to miſtruſt the goodneſs of this character. We have obſerved it. Every thing in nature is graduated or ſhadowed; we cannot then determine the preciſe part where the feeling begins; it is poſſible that it may extend even to plants, at leaſt to ſuch as bear the greateſt reſemblance to animals. Let us inquire farther into this.

Feeling is that agreeable or diſagreable impreſſion which certain objects produce on an organized and animated being, by virtue of which it ſeeks after the one, and avoids the other. We judge of the exiſtence of feeling in an organized body, either by the conformity or analogy of its organs with ours, or by the conformity or analogy we obſerve between the motions it affords in certain circumſtances, and thoſe we ſhould exhibit were we placed in the ſame circumſtances. The firſt method of judging is pretty certain; it is very probable that an organized body which has eyes, ears, and a noſe, is endued with the ſame ſenſations which theſe ſenſes excite in us. The ſecond method of judging ſeems leſs certain, or leſs free from ambiguity; becauſe we are often apt to transfer to other beings thoſe ſenſations which are peculiar to ourſelves.

However, when we ſee an organized body, whoſe ſtructure has no relation with ours, and in which we do not ſo much as diſcover the organs of the ſenſes, contract itſelf with an extraordinary degree of readineſs, on touching ſome body; turn itſelf towards the light; ſtretch out its long arms to ſeize the inſects that paſs near it; carry theſe inſects near to a hole placed in its fore-part; when, I ſay, we obſerve all this, we ſcarce heſitate at all to range this body amongſt the number of animate bodies: and this judgment is very natural.

Let us cut off from the body theſe long arms; let us reduce it to the bare power of contracting and extending itſelf; it will not, in conſequence of this, be leſs an animal; but the ſigns whereby it will manifeſt to us what it is, will be leſs numerous, and more doubtful.

Let us farther deprive it of the faculty of contracting and extending itſelf; or at leaſt let us only leave it an almoſt inſenſible motion; the main par

of its being will not be changed on this account, but it will become more obſcure to us. Such is nearly the ſtate in which the ſmalleſt pieces of a polypus are found before they begin to reſume a head. Any one who ſhould then ſee them, would undoubtedly forget their real nature.

May not that be the caſe of plants, and did not that philoſopher who defined them rooted animals, diſcourſe in a very rational manner? We have already remarked, that the expreſſion of feeling is relative to the organs which manifeſt it. Plants are utterly unable to make us acquainted with their feeling; this ſenſation is perhaps extremely weak, without will and without deſire, ſince their inability to manifeſt it to us proceeds from their organization, and that there is room to think the degree of ſpiritual perfection correſponds with the degree of corporeal perfection.

Be this as it may, by depriving plants of feeling, we cauſe nature to take a leap, without aſſigning the cauſe; we ſee feeling gradually decreaſe from the man to the ſea-nettle or muſcle; and we perſuade ourſelves that it ſtops there, on conſidering theſe laſt animals as the leaſt perfect. But perhaps there may be many degrees between the feeling of the muſcle and that of the plant. There may poſſibly be ſtill more between the moſt ſenſible plant and that which is leſs ſo. The gradations we obſerve every-where ſhould convince us of this philoſophy; the new degree of beauty it ſeems to add to the ſyſtem of the world, and the pleaſure there is in multiplying ſenſible beings, ought to contribute ſtill farther to induce us to admit it. I will then frankly acknowledge that this philoſophy is very agreeable to my liking. I have a pleaſure in perſuading myſelf that theſe flowers which deck our fields and gardens with a magnificence which is always new, theſe fruit-

trees which ſo agreeably affect our eyes and palates, theſe majeſtic trees which compoſe thoſe vaſt foreſts which time itſelf ſeems to have reſpected, are ſo many ſenſible beings, that reliſh, in a manner ſuitable to them, the comforts of exiſtence.

CHAP. XXXI.

Continuation of the ſame Subject.

WE have ſeen, that there is not found in a plant any organ adapted to feeling; but if *nature* ought to make the ſame inſtrument ſerve for ſeveral ends, if *ſhe* ſhould avoid multiplying parts, it muſt certainly be in the conſtruction of machines extremely ſimple, ſuch as the body of a plant. Veſſels which we ſuppoſe to be appointed ſolely for the conveyance of the air or ſap, may alſo be in the plant the ſeat of feeling, or of ſome other faculty of which we have no idea. The *nerves* of the plant, without doubt, differ as much from thoſe of the animal, as the ſtructure of the one differs from that of the other.

Plants preſent us with ſome circumſtances which ſeem to indicate that they have feeling; but I don't know whether we are in a proper ſituation to obſerve them, or whether the ſtrong perſuaſion we have ſo long entertained of their being inſenſible, will permit us to judge rightly of them. In order to this, we muſt be a *carte blanche* on the queſtion, and bring plants to a new trial, both more important and more exempt from prejudices. An inhabitant of the moon, who has the ſame ſenſes and the ſame ſhare of underſtanding with ourſelves, but who is not prepoſſeſſed concerning the inſenſibility of plants, is the philoſopher we are ſeeking for.

Imagine

Imagine that ſuch an obſerver had lately ſtudied the productions of our earth, and that after having beſtowed his attention on polypuſes and other inſects which multiply by ſlips, he proceeds to the contemplation of vegetables. He would undoubtedly trace them from their origin. For this purpoſe he would ſow ſeeds of different ſpecies, and would attentively obſerve their ſpringing up. Suppoſe ſome of theſe ſeeds had been ſown the contrary way, the radicle being turned upwards, and the *plumula* or little ſtalk downwards. We will likewiſe ſuppoſe that our obſerver knows how to diſtinguiſh between the radicle and the *plumula*, and is acquainted with the functions of both. After ſome days he will remark, that the radicle will raiſe itſelf to the ſurface of the earth, and the *plumula* will ſink down into it. He will not be ſurpriſed at this direction, ſo prejudicial to the life of the plant: he will impute it to the poſition he gave to theſe ſeeds when he ſowed them. He will purſue his obſervations, and will ſoon ſee the radicle fold back on itſelf, in order to gain the inſide of the earth, and the *plumula* bend backwards in like manner, in order to raiſe itſelf into the air. This change of direction will appear to him very remarkable, and he will begin to ſuſpect that the organized being he has been ſtudying is endued with ſome diſcernment. Nevertheleſs, being too wiſe to pronounce his opinion on theſe firſt indications, he will ſuſpend his judgment, and purſue his inquiries.

The plants whoſe coming up our natural philoſopher has been obſerving, received their birth near a covert. Being favoured by this ſituation, and cultivated with care, they made a conſiderable progreſs in a ſhort time. The earth, which encompaſſes them at ſome diſtance, is of two very oppoſite qualities. That part on the right ſide of the plants is

moiſt, rich, and ſpongy; that on the left is dry, hard, and gravelly. Our obſerver remarks, that the roots, after having begun to extend themſelves pretty equally on both ſides, changed their courſe, and directed themſelves intirely towards that part of the ſoil which is fat and moiſt. They even lengthened to ſuch a degree, as made him apprehenſive they would intercept the nouriſhment from the neighbouring plants. To prevent this inconvenience, he contrives to make a ditch, which ſeparates the plants he is obſerving from thoſe they threaten to famiſh, and thus thinks he has provided againſt all events. But theſe plants which he flatters himſelf to have ſo eaſily maſtered, elude his prudence: they cauſe their roots to paſs under the ditch, and conduct them to the other ſide.

Surpriſed at this, he uncovers one of theſe roots, but without expoſing it to the heat: he holds a ſponge towards it filled with water. The root ſoon inclines itſelf towards this ſponge. He ſeveral times ſhifts the place of the latter; the root follows it, and conforms to all its poſitions.

Whilſt our philoſopher is profoundly meditating on theſe things, other circumſtances equally remarkable offer themſelves to him almoſt at the ſame inſtant. He obſerves that all his plants have quitted the ſhelter, and have inclined themſelves forwards, as though they would preſent every part of their bodies to the benevolent aſpect of the ſun. He farther obſerves, that the leaves are all directed in ſuch a manner, that their upper ſurface faces the ſun or the open air, and their lower the covert or the ground. By ſome experiments which he has heretofore made, he has learnt, that the upper ſurface of the leaves ſerves principally for a defence to the lower; and that this laſt is chiefly appointed for pumping out the moiſture ariſing from the earth, and

for

for procuring the evacuation of what is ſuperfluous. The direction he obſerves in the leaves ſeems to him greatly to coincide with his experiences. From thence he becomes more intent on ſtudying this part of the plant.

He remarks that the leaves of ſome ſpecies ſeem to follow the motions of the ſun, ſo that in the morning they are turned towards the eaſt, and in the evening towards the weſt. He ſees other leaves cloſe themſelves at the ſun in one way, and at the dew in an oppoſite manner. He obſerves an analogous motion in ſome flowers.

Conſidering afterwards, that whatever may be the poſition of the plants with reſpect to the horizon, the direction of the leaves is always nearly the ſame as he at firſt obſerved it, it comes into his mind to change this direction, and to place the leaves in a ſituation exactly contrary to that which is natural to them. He has already had recourſe to like means for informing himſelf of the inſtinct of animals, and to know its tendency. With this view he inclines towards the horizon thoſe plants which were perpendicular to it, and retains them in this ſituation. By this means the direction of the leaves is found to be abſolutely changed; the ſuperior ſurface, which before looked to the ſky or free air, now inclines to the earth or the inner part of the plant; and the inferior ſurface, which before looked to the earth or the inſide of the plant, tends towards the ſky or the open air. But all theſe leaves ſoon put themſelves in motion: they turn on their pedicle like a hinge, and in a few hours reſume their former ſituation. The ſtalk and branches alſo grow ſtrait again, and diſpoſe themſelves perpendicular to the horizon.

Each part of a *ſtar-fiſh*, a *ſea-nettle*, and a *polypus*, has eſſentially in miniature the ſame ſtructure which the whole has more at large. It is the ſame

with reſpect to plants. Our obſerver, who is not ignorant of this, is deſirous of informing himſelf whether leaves and branches, when detached from their ſubject, and plunged into veſſels full of water, will there preſerve the ſame inclinations as they had on the plant of which they made a part; and this his experience convinces him of in ſuch a manner as leaves him no room to doubt of it.

He places wet ſponges under ſome of the leaves. He ſees theſe leaves incline towards the ſponges, and endeavour to touch them with their inferior ſurface.

He obſerves farther, that ſome plants which he has ſhut up in his cloſet, and others which he has carried into his cellar, have directed themſelves towards the window or the air-holes.

In ſhort, the *phænomena* of the *ſenſitive*, its various motions, the quickneſs with which it contracts itſelf on the approach of the hand, are the intereſting ſubject which terminates his reſearches *.

Overwhelmed with ſo many facts which ſeem to depoſe in favour of the feeling of plants, what ſide ſhall our philoſopher take? Shall he yield to theſe proofs; or ſtill ſuſpend his judgment like a true *Pyrrhonian?* I think he will embrace the former opinion, eſpecially if he compares again theſe facts with thoſe exhibited to him by ſuch animals as come the neareſt to plants.

But it will be ſaid, Your philoſopher might know that it is eaſy to explain mechanically all theſe facts, which ſeem to prove to him the ſenſibility of plants. It is ſufficient if we admit that ſome vegetables have fibres which contract themſelves from moiſture, and others which contract themſelves from dryneſs. This is true, and our philoſopher knows it very well; but he likewiſe knows, that ſome have undertaken

* See part vi. chap. 3, 4.

dertaken to explain mechanically all the actions of animals, not only thoſe which demonſtrate they have feeling, but alſo thoſe that ſeem to prove they are endued with a certain degree of underſtanding. Extraordinary procedure this of the human mind! Whilſt ſome philoſophers attempt to ennoble plants by raiſing them to the rank of ſenſible beings, others endeavour to debaſe animals by reducing them to the rank of mere machines.

Finally, The judicious reader will readily comprehend, that my only intention has been to make it appear by a fiction, how greatly our judgments are hazarded in maintaining the inſenſibility of plants. I have not pretended to prove that plants are *ſenſible*; but I would ſhew that it has not hitherto been proved that they are not ſo.

CHAP. XXXII.

Nutrition.

SINCE then the faculty of feeling furniſhes us but with a doubtful character for diſtinguiſhing the vegetable from the animal, which is that we ſhould have recourſe to with this view? I think we have exhauſted them all; we have at leaſt treated of them all in a curſory manner. But we have not examined them all under their various aſpects. There is one of them, which, being conſidered in a certain point of view, may perhaps procure us what we have in vain ſearched for in the others.

We are now diſcourſing of the poſition of thoſe organs by which plants and animals receive their nouriſhment. Theſe organs in plants are the roots and leaves. Both of them are furniſhed with pores, by means of which they pump in the nutritious

juice. Theſe pores terminate at ſmall veſſels, which tranſmit the juice into the inner part; or rather, theſe pores are only the extremity of theſe veſſels.

Animals have organs which are intirely analogous to roots and leaves; I mean *lacteal veins*, or veſſels which anſwer the ſame purpoſe. Theſe veins open themſelves in the inteſtines, and pump the chyle into them, which they convey into the channels of circulation*.

An animal is then an organized body, which is nouriſhed by roots placed *within him*. A plant is an organized body which receives its nouriſhment by means of roots placed *on its outſide*.

Thus there is certainly a very ſmall difference between the plant and the animal: this however is all we have been able to find that is moſt diſtinguiſhing amongſt the various characters which have offered themſelves to our inquiries. It is not nevertheleſs certain, that this new character is as diſtinctive as it has appeared to be, and that ſome unforeſeen diſcoveries may not deſtroy it. An animal which is nouriſhed by the whole habit of its body, or by pores diſtributed on its outſide, renders this character inſufficient or ambiguous. The *tape-worm* ſeems not very different from ſuch an animal. This worm, as we have already remarked, is of a prodigious length. It forms in the inteſtines a great number of plaits and wrinkles: and ſometimes it intirely fills the capacity of this canal. Each of the rings that compoſe it, and whoſe length is rarely more than one or two lines, is pierced with a ſmall round aperture, by which one may ſee the chyle iſſue which the worm is full of, and which conſtitutes its principal nouriſhment. If this aperture is a kind of ſucker, by the help of which the inſect pumps the chyle that ſur-

* See chap. 27, 28. of this part.

rounds

rounds it, this method of nouriſhing itſelf varies but little from that of plants. It is true there has been diſcovered at the ſlendereſt extremity of this worm a head furniſhed with four nipples, which have appeared to be ſo many pumps or ſuckers. But this diſcovery does not ſet aſide the conjecture we lately ventured to form concerning the uſe of thoſe provident apertures in animals.

We know of another animal production which ſeems to receive nouriſhment in a manner nearly reſembling that whereby plants are nouriſhed. This production is the egg of a fly, which pierces the leaf of the oak, and cauſes a gall-nut to be formed in it, in the centre of which is found the egg. It is membranous, and of an uniform make. We cannot diſcover in it any particular hole by which it is nouriſhed. However it is certain that it is nouriſhed, and acquires a conſiderable growth. This gives room to think that their membranes are conſtructed with ſo much art, that they pump in the juices which are communicated to them. When we open thoſe gall-nuts which are juſt formed, we find in them an egg which is as yet very ſmall. It is much larger in gall-nuts of a more advanced age. It is even conjectured, with ſome degree of probability, that the growth of the egg effectuates that of the gall-nut, and that the continual conſumption of juices occaſions them to be conveyed thither in greater plenty.

But without ſeeking very far for examples of animals that are nouriſhed like plants, this is the caſe of all animals, whether oviparous or viviparous, whilſt they are incloſed in the egg, or in the belly of their mother. The *umbilical* veſſels may be conſidered, in the matters of the egg or in the matrix, as roots which imbibe the nouriſhment appropriated to the *fœtus*. It is the ſame with reſpect to inſects

that multiply *by ſhoots*. Whilſt the young one ſtill adheres to its mother, it ſeems to be nouriſhed in a manner little different from that which is peculiar to branches. Animal grafts nearly reſemble vegetable likewiſe in this particular.

Laſtly, The ſkin of the human body imbibes, like the leaves of plants, the vapors and exhalations with which the air abounds; and although men draw in much leſs nouriſhment by this means than vegetables, it is nevertheleſs true that their ſkin and leaves have, in regard to this circumſtance, a great affinity to each other. Perhaps we may be able ſome time or other to diſcover animals which are nouriſhed by their ſkin only, as certain plants are by their leaves.

CHAP. XXXIII.

Irritability.

DO we then in vain ſeek for a peculiar character whereby we may diſtinguiſh the vegetable from the animal? Ought we to renounce this inquiry, and leave it to time to reſolve this problem? I perceive a new property, which will perhaps furniſh us with what we have ſought for elſewhere to no purpoſe. Let us ſee what judgment we are to form of it.

A *muſcular* fibre contracts or ſhortens of itſelf on the touch of all bodies, whether ſolid or liquid. This property, which is ſo remarkable, is known by the name of *irritability*. We took a ſlight view of it at the end of chap. 2. part vi.

It has nothing in it common to ſenſibility. The parts which are moſt ſenſible are not *irritable*, and the parts which are moſt irritable are not *ſenſible*.

Neither ought we to confound irritability with *elaſticity*. A dry fibre is very elaſtic, and not at all irritable.

irritable. One would not imagine that animals which are purely gelatinous ſhould be elaſtic, and are notwithſtanding very irritable. There have been no eyes diſcovered in the polypus; nevertheleſs he turns himſelf towards the light, probably by an effect of the exquiſite irritability with which he is endued. In ſhort, the fibres of old men, though much more elaſtic than thoſe of infants, are much leſs irritable.

If we deprive any muſcle whatever of all commerce with the brain, either by tying the nerves, or by cutting them, and irritate this muſcle with the point of a needle, or with a liquor that is a little acid, it will immediately aſſume a contraction, and we may cauſe it to repeat the ſame motion ſeveral times together.

We have ſeen * that the heart is a real *muſcle*. If we extract it from the breaſt, it will continue to move till it has loſt its natural heat. The heart of a viper or tortoiſe beats ſtrongly for the ſpace of twenty or thirty hours after the death of the animal. Water or air, when introduced into the *ventricle*, are ſufficient to reſtore to the heart the motion it has loſt.

The *periſtaltic* motion of the inteſtines is likewiſe owing to their irritability. But the following is what we ſhould not have gueſſed at. If they are plucked haſtily from the lower belly, and cut into pieces, all theſe pieces will crawl like worms, and contract themſelves on the ſlighteſt touch. It is not therefore much to be wondered that the parts of living inſects ſhould alſo move after being ſeparated from the bulk. The fact I mentioned in the ſecond chapter of part viii. is of the ſame kind, and depends on the ſame principle.

So that not only every muſcle, but alſo every fragment of a muſcle, and even every muſcular fibre,

* Part vii. chap. 4. and chap. 27. of this part.

contract

contract themſelves more or leſs on being touched by any body whatſoever, eſpecially if that body be of a ſtimulating nature. And as the fibre contracts of itſelf, ſo it likewiſe recovers of itſelf, and this alternate exerciſe laſts for a time proportionable to the degree of irritability.

A natural philoſopher, who has fixed in the ſoul the cauſe of all the motions of the body, has been under the neceſſity, in order to explain the matter in diſpute, of ſuppoſing that the ſoul is *diviſible*. There is then a part of a ſoul, or a little ſoul, in every muſcle, in every fragment of a muſcle, in each muſcular fibre, in the ſting of a waſp, in the tail of a lizard, *&c.* But the ſoul, on the loſs of a member, does not change; it has always the ſame will, the ſame ideas, *&c.* The ſoul would not therefore be in this member, it belonged not to the foundation of her being; it belonged ſtill leſs to any other ſoul; it was not——but I have already too long dwelt on an opinion which ſhocks common ſenſe as much as metaphyſics.

It has been known for ſeveral ages, that the right *lobe* and *ventricle* of the heart were thoſe parts of the animal body which moved the longeſt time after death. It was reſerved for an illuſtrious modern to make known to us the cauſe of this *phænomenon*, and in general that of the motions of the heart. We have admired the wonderful irritability of this muſcle. The contact of the blood is that alone which diſplays it. If we prevent the blood from acting on the lobe or ventricle, all motion immediately ceaſes, and it is reproduced the very moment the blood is ſuffered to enter. Blood is not abſolutely neceſſary in order to this; every other liquid produces the like effects; and we have ſeen that water and air act herein like the blood.

It

It is evident, from all the experiments made concerning irritability, that the *vital* parts are the moſt irritable. The heart is the moſt irritable of all, and, next to that, the inteſtines and diaphragm.

The muſcular fibre is compoſed of two very different principles, of a friable *earth* and a kind of glew. In this the irritability reſides; for we are very ſenſible that a friable earth is not of itſelf capable of executing alternate contractions and relaxations.

The nature of irritability is as unknown as that of any other force: we only judge of it by its effects. But we very well conceive, that the muſcular fibre muſt have been conſtructed on relations determined by the method of acting of this ſecret force. The nature, form, and reſpective arrangement of the elements of the fibre are then in a direct relation with this force.

It probably reſides in the elaſtic fluid which is interſperſed between the *lamellæ* of the fibre; for it would not be ſufficient to have recourſe to the primitive ſtructure of the latter, in order to aſſign a reaſon for its irritability. The body, which is indifferent to reſt or motion, is not leſs ſo with reſpect to every kind of ſituation. The elements, which approach each other in contraction, would not recover themſelves without an extraneous force. But this force in its turn ſuppoſes particular conditions in the elements, and theſe conditions are what diſtinguiſh the *muſcular* fibre from every other.

The *nerves* are not irritable; that is at preſent ſufficiently demonſtrated: but if a nerve be pricked, the muſcle at which it terminates will contract itſelf. You have ſeen this in the ſilk-worm *. The nerves may then give motion to the muſcles; they do not communicate an irritability to them which they are

* Part viii. chap. 2.

no

not poſſeſſed of themſelves; they only put it into action, and thus they are the miniſters of the affections of the ſoul. They are not that, however, of themſelves; divers experiments evince, that it is by the intervention of a very ſubtile and very active fluid. Could the *nervous* fluid then act on the muſcles like a true *ſtimulus?* Could it increaſe their natural tendency to contract themſelves?

Irritability then ſeems to be what conſtitutes the *vital power* in the animal. This property has not yet been perceived in the vegetable. Can it be that *diſtinguiſhing* character we ſeek for? But is it indeed certain that vegetables are not irritable? Have all their parts been ſubmitted to the requiſite proofs? Have they not attributed to the elaſticity of ſome of them thoſe *phænomena* which perhaps depend on irritability? Are we quite certain that thoſe motions, apparently ſo ſpontaneous, of roots, ſtalks, leaves, flowers, *&c.* of which I made mention in the 31ſt chapter, are not in any degree owing to irritability? It reſides in the *gelatinous* ſubſtance of the animal: Have we well conſidered the gelatinous ſubſtance of the vegetable? The hardeſt wood was at firſt only a *jelly*, and the majeſtic cedar of *Libanus* no more than a drop of mucous matter. A ſound logician adviſes us ſtill to ſuſpend our judgment, and wait for the deciſion from experience.

CHAP. XXXIV.

Concluſion.

TELL the vulgar that philoſophers meet with ſome difficulty in diſtinguiſhing between a cat and a roſe-tree; they will laugh at ſuch philoſophers, and aſk if there can be any thing in the world that is more

more eaſy to diſtinguiſh? Becauſe the common people, who are ignorant of the art of *abſtracting*, judge on *particular* ideas, and philoſophers on *general* ones. Take away from the notion of the cat and that of the roſe-tree all thoſe properties which conſtitute the *genus* and claſs in each of the ſpecies, ſo as to retain only the moſt general properties which characteriſe the animal or plant, and there will remain no real *diſtinctive* mark between the cat and roſe-tree. The parallel we have lately made between plants and animals ſets this in the ſtrongeſt light.

We endeavour to eſtabliſh general rules concerning the nature of plants and animals. We would judge of the unknown by what is known, and have confined nature within the narrow limits of our actual knowledge. Can we judge of the *polypus* by thoſe animals we are acquainted with? And how many properties are there in thoſe animals we think we know, that we are ſtill ignorant of? What a ſmall number of animals and vegetables are known to us, in compariſon of thoſe which are not yet diſcovered? How many unknown animals exiſt, whoſe properties would ſurpriſe us as much as thoſe of the polypus, and which perhaps differ more widely from it than the properties of the polypus differ from thoſe of ſuch animals as are moſt familiar to us? Obſerve how much the *cluſter-polypuſes* differ from the polypuſes *with arms* in their manner of living, growing, and multiplying? Recall to mind the method by which the *flying-ſpider* is bred *, and that whereby certain *millepedes* † grow and propagate, and you will be ſenſible that natural hiſtory is the beſt logic. The world teems continually with new productions: ours are but the obſervations of an

* Part ix. chap. 7. † Ibid. Chap 14. of part vii. and chap. 4. of part ix.

hour,

hour, yet we presume to pronounce our opinions concernining the ways of nature!

If before the discovery of the polypus, those who form general rules had been asked their sentiments concerning a being that multiplied by slips and shoots, and that might be grafted, they would undoubtedly have answered, that this being was a plant. But if they had been told that this being lived by prey, which it could seize with a net, devour and digest it, they would then have called this being an *animal plant*, and would have thought they had given a happy definition of it. If they had afterwards learnt, that it possessed a property unknown in the plant, that of being turned inside out like a glove, they would in all probability have judged that this being was neither plant nor animal, and would have placed it in a particular class.

The polypus is not, strictly speaking, an animal-plant; it is still less a being that neither belongs to the class of animals or that of vegetables: it is a real animal, but one that has more relations with the plant than other animals have.

Nature descends by degrees from man to the polypus, from the polypus to the sensitive, from the sensitive to the truffle. The superior species are always connected by some character with the inferior; the latter to more inferior still. We have much contemplated this wonderful chain. * *Organized* matter has received an almost infinite number of various modifications, and all are shaded like the colours of a prism. We make points on the representation, trace lines on it, and term that forming *genera* and *classes*. We only perceive the most glaring strokes, and the delicate shadowings escape our sight.

Plants and animals then are only modifications of organized matter. They all partake of a similar

* Part ii. iii. iv. viii. chap. 17.

essence,

eſſence, and the diſtinguiſhing attribute is unknown to us. We thought ourſelves acquainted with the principal properties of the animal body, *irritability* came and convinced us of our ignorance; and this new property, concerning which we make ſo many and ſuch curious experiments, is at preſent only known to us by ſome *effects*.

PART XI.

Of the induſtry of animals.

INTRODUCTION.

HITHERTO we have ſcarcely conſidered animals in any other light than with reſpect to organization, and the moſt immediate and general conſequences reſulting from it. We will now contemplate their induſtry, which is ſtill more intereſting to us. We ſhall not make uſe of the eyes of the naturaliſt or obſervator: they ſee too many things, and particularize them with too much exactneſs; employ we here thoſe of a contemplator, who only fixes on the moſt ſtriking parts of each kind, goes through them with rapidity, and continually avoids giving tedious deſcriptions of them.

CHAP. I.

Treating in general of the inſtinct of animals.

SOME animals ſeem reducible to feeling only. Others have all our ſenſes, and riſe almoſt to underſtanding. The diſtance from the *polypus* to the *ape* appears enormous.

Imagi-

Imagination and memory are obſervable in divers ſpecies: imagination in their dreams; memory, in the recollection of ſuch things as have affected them. Places, perſons, animate and inanimate objects are traced out in their brain, and they act agreeably to theſe repreſentations.

The degree of knowledge in each ſpecies anſwers to the place it occupies in the general plan. The ſphere of this knowledge extends to all caſes wherein the animal may naturally meet. And if by means of men, or otherwiſe, the animal happens to be drawn from his natural circle, and nevertheleſs is not intirely removed out of it, we may from thence conclude that this new ſituation has a relation to one of the caſes to which the ſphere of his knowledge extends. The more or leſs eaſe he will then expreſs in his manner, will indicate whether this relation is near or remote, direct or indirect.

The way whereby animals vary their proceedings as neceſſity requires, furniſhes one of the ſtrongeſt arguments againſt the opinion which transforms them into mere machines. The philoſopher who attributes to them a ſoul, founds his judgment on the analogy of their organs with ours, and of their actions with ſeveral of ours. Thoſe who make the ſoul material, forget that the ſimplicity of feeling is incompatible with the properties of matter, and that faith is very independent of our ſyſtems concerning the nature of the ſoul.

The greater the number of caſes is to which the knowledge of an animal extends, or may extend itſelf, the higher is this animal elevated in the ſcale.

The preſervation of life, the propagation of the ſpecies, and the care of their young, are the three principal branches of the knowledge of animals, but all are not alike to be admired in theſe three reſpects.

The *oyſter*, immoveable on its veſſel, knows only how to open and cloſe its ſhell. The

The induſtrious *ſpider* ſpreads a net for his prey. Waſts like a patient huntſman, till ſome inſect falls into the ſnare. Hardly has he touched it, before he darts upon it. Is he armed or too nimble? He faſtens the limbs to him with wonderful ſkill, and thus diſables it either from flying or defending itſelf.

Divers ſpecies of animals live from day to day without taking any thought for the ſucceeding day.

Others ſeem endued with a kind of foreſight, conſtruct magazines with abundance of art, which they fill with various kinds of proviſions: ſuch are the *bee* and the *beaver*.

Amongſt animals that live by prey, ſome, like the *eagle* and the *lion*, attack with open force. Others, as the *hawk* and the *fox*, join craft to ſtrength. Some ſave their lives by flight; others by hiding themſelves under the earth or water; whilſt others ſtill have recourſe to divers ſtratagems to facilitate their flight, and evade the purſuit of their enemy. The hare affords a familiar example of the latter. Others, in the laſt place, oppoſe force to force.

Thoſe philoſophers, who take a great deal of pains to define *inſtinct*, are not aware, that in order to do it, they ſhould ſpend ſome time in the head of an animal, without becoming the animal itſelf. To ſay in general, that inſtinct is the reſult of the impreſſion of certain objects on the machine, of the machine on the ſoul, and of the ſoul on the machine; is to ſubſtitute terms that are a little leſs obſcure, inſtead of a very obſcure term; but the idea does not iſſue from the thick darkneſs that covers it. We well know what is not inſtinct, but are utterly ignorant what it is. It is not underſtanding or reaſon. The brute has neither our notions, nor our *mean* ideas; becauſe it has not our *ſigns*.

CHAP.

CHAP. II.

Wiſdom diſplayed in the preſervation of the ſpecies.

AT the ſame time that NATURE has taught divers animals the method of attacking and purſuing their prey, ſhe has inſtructed them in that of ſelf-defence or eſcaping. If we were converſant in the books of nature, we ſhould there ſee, without doubt, that the profit always makes amends for the loſs. A regiſter of the births and deaths of ſome ſpecies, puts this truth beyond all controverſy.

Thoſe ſpecies which multiply moſt, have the greateſt number of enemies. *Caterpillars* and *vine-fretters* are attacked as much within as without, by I know not how many inſects, that are always bent on deſtroying the individuals, without being able to effect the deſtruction of the ſpecies.

Many ſpecies ſeek their living or retreat in the inner part of the earth, or in that of plants and animals.

Others build themſelves neſts or ſhells with amazing art, where they paſs their time in weakneſs and inactivity.

Some that are more ſkilful than theſe, can, like us, make themſelves cloaths, and even procure matter for their nouriſhment. They ſtrip our cloths and furs of their hairs, and with ſilk make a kind of ſtuff of it, wherewith they clothe themſelves. The form of their dreſs is very ſimple, but very commodious. It is a ſort of muff or caſe, which they can lengthen or widen as they find occaſion. They lengthen it by adding to each end new layers of ſilk and hair, and widen it as we do a glove, by cutting it in the middle according to the length of it, and by ingrafting a piece. You may imagine

imagine that I am ſpeaking of *houſe-moths*; *field-moths*, which clothe themſelves with leaves, ſurpaſs them in induſtry. We ſhall elſewhere take a ſlight view of them at their work.

Several kinds of *fiſhes* and *birds* change, at a ſtated time, their dwelling-places or climates. We have ſeen numerous ſhoals of *herrings* and *cod-fiſh*, and *flocks* of *geeſe*, *quails*, and *crows*, &c. reſembling thick clouds, that ſometimes darken the air. By ſuch periodical emigrations the ſpecies are preſerved, and in their long pilgrimages Nature is their pilot and provider.

CHAP. III.

The propagation of the ſpecies.

THE *polypus*, deprived of ſex, is unacquainted with the pleaſures of love. The *butterfly*, happier than that, flutters round his female, and ſolicits by his ſportiveneſs thoſe favours which ſhe at firſt ſeems to refuſe him, only the more to inflame his deſires. The *queen-bee*, enthroned amidſt a ſeraglio of males, chooſes one that pleaſes her beſt, and by her inticements overcomes his natural coldneſs and indolence. The *toad* claſps his female in his embraces for the ſpace of forty days, and performs to her the office of a midwife when the time of her delivery is come. The proud *bull*, diſdaining to play wantonly round the young heifer, ruſhes on her with impetuoſity. The *pigeon*, faithful to its mate, does not laviſh its careſſes on others. The *cock*, leſs reſerved in his amours, diſtributes his favours indifferently amongſt a number of hens.

You may obſerve likewiſe the anxious care which the males of ſeveral ſpecies take of their females, either by ſharing with them part of the food they diſcover,

diſcover, by adminiſtring comfort to them in their labour, or laſtly by defending them againſt the inſults of their own ſpecies, or from their enemies.

CHAP. IV.

Reflections on the multiplication produced by the concurrence of the ſexes.

WE do not wonder at this intercourſe, becauſe it is always before our eyes; but when we come to examine it philoſophically, it ſurpriſes as much as it embarraſſes us; chiefly when we reflect on what paſſes amongſt vine-fretters * and polypus's †.

Hence ariſes a queſtion: What is the metaphyſical reaſon of the concurrence of the ſexes? This reaſon, like that of all *particular* ſyſtems, is compriſed in the *general* ſyſtem, of which our feeble ſight can only diſcern ſome ſmall parts. Let us confine ourſelves here to the obſervation of the fact, and its mediate and immediate conſequences.

We ſee at once, that the diſtinction of ſexes makes way for a kind of ſociety between the male and female, from whence reſult advantages that are common to both, and which extend themſelves to the individuals that are produced from their union.

It is obſervable, that thoſe animals which are naturally endued with fecundity, live without ſeeming to form themſelves into real ſocieties, though aſſembled in great numbers in the ſame place. It is farther remarked, that they take no care of their young. It is true, the latter are in a condition to diſpenſe with their aſſiſtance.

Another remark is; that ſuch animals as are fecund of themſelves, multiply prodigiouſly, and with

* Part vii. chap. 8. † Ibid. chap. 11, 12, 13. 15.

extreme

extreme facility. The earth would not have held and maintained the various ſpecies, had they been all furniſhed with the ſame degree of fruitfulneſs. The abſolute and mutual dependence of the two ſexes renders propagation leſs certain, leſs abundant, and leſs eaſy, than among ſuch hermaphrodites. So that the ſame means that promote the multiplication of the greateſt part of animals, ſerve them at the ſame time for a barrier or curb.

In ſhort, the diſtinction of ſexes diſperſes throughout nature an agreeable variety, and renders the ſeveral ſervices men derive from animals more extenſive.

This ſecret impulſe which induces the two ſexes to ſeek each other and unite together, is a ſtrong argument in favour of *ends*. This mover, which is inherent in the nature of the animal, does not depend on foreign cauſes. It acts in animals brought up in ſolitude as well as in thoſe that live in ſociety. The temperature of the air, food, education, and other circumſtances, may indeed modify the exerciſe of it, but cannot deſtroy it. And farther, what numbers of very-complicated relations are there between the organs peculiar to each ſex, and the correſponding organs of the two ſexes! How many particular ends, all of which here conduce to one general end! What connexions, what conveyance in the means! What benefits in the deſign, and what conſequences from the whole of it!

In females there are for the moſt part ſeaſons appointed for generation: the males would ſolicit them in vain at other times; they would then repulſe them, or withdraw from their addreſſes. The reaſon of this order is plain: generation would have been diſturbed or interrupted, were theſe females to receive the males at all times.

CHAP. V.

The place and arrangement of eggs, and the care of young.

THE *graſhopper*, *lizard*, *tortoiſe*, and *crocodile* furniſh examples of animals that ſcarce take any care of their eggs, and are almoſt wholly unmindful of the young that are hatched from them. They lay them in the earth or ſand, and leave the ſun to communicate the warmth neceſſary for them. Shell-fiſh practiſe the ſame method: ſome ſpawn in the water, others between ſtones or in the ſand.

The inſtinct of the different ſpecies conſiſts in depoſiting them in ſuch places, where the young may find proper nouriſhment at their birth. The mothers commit no miſtake with reſpect to that. The *butterfly* of the *cabbage-caterpillar* never lays her eggs on meat, nor the *fleſh-fly* on the cabbage.

The gnat, that flutters in the air, was at firſt an inhabitant of the water. For this reaſon her eggs are always depoſited in the water. The maſs formed by them reſembles a little veſſel which the inſect ſets afloat. Each egg is in the form of a keel. All the keels are vertical, and are diſpoſed back to back. The gnat lays but one egg at a time. We cannot deviſe how ſhe can cauſe the firſt egg or keel to remain on the water. Her method is nevertheleſs very ſimple, but much more ingenious. She ſtretches her long legs behind her, croſſes them, and by thus forming an angle of them receives the firſt egg, and holds it at pleaſure. A ſecond egg is ſoon placed next the firſt, then a third, fourth, &c. The baſe of the pyramid thus widens by little and little, and at length is capable of ſuſtaining itſelf.

Some

Some ſpecies glue their eggs with great ſymmetry and propriety round the branches or ſmall ſhoots of trees, like rings or circles. One would be apt to ſay, that ſome ſkilful hand had been diverting itſelf in fitting pearl bracelets on the ſprigs. A caterpillar, which, from the diſtribution of its colours is called *livery*, transforms itſelf into a butterfly, that diſpoſes her eggs in this manner, and forms theſe pretty bracelets of them.

Other butterflies do ſtill more: they ſtrip themſelves of their hair, and make with it a kind of neſt for their eggs, where they lie ſoft and warm. Such in particular is the induſtrious workmanſhip of the butterfly proceeding from that called the *common* caterpillar, becauſe it is in fact moſt common in theſe countries.

Certain ſpecies are ſo attached to their eggs, that they carry them about with them every where. The *wolf* ſpider incloſes hers in a little ſilk purſe, which ſhe bears on her hind-part. Does any one attempt to deſtroy it or take it from her? Her natural vivacity and agility abandon her: ſhe ſeems to fall into a kind of languor. Has ſhe the happineſs to recover the precious truſt? She inſtantly ſeizes it, carries it away, and betakes herſelf to flight. As ſoon as the little ſpiders are hatched, they collect and arrange themſelves ſkilfully on the back of their dam, who continues for ſome time to beſtow her attention on them, and to tranſport them with her where-ever ſhe goes.

Another ſpider lodges her eggs in a little ſilk purſe, which ſhe wraps up in a leaf. She fixes herſelf on this purſe, and ſits on her eggs with amazing aſſiduity. Another, to conclude, incloſes her's in two or three little ſilk balls, which ſhe ſuſpends by threads, but has the precaution to hang before, at a ſmall diſtance, a little bunch of dry

leaves, to conceal them from the inſpection of the curious.

Divers ſpecies of *ſolitary* flies are not leſs to be admired, as well for their foreſight in amaſſing proviſions for their little ones, as for the art diſplayed by them in the neſts they prepare for their reception. The *maſon* bee, ſo called becauſe, like us, ſhe underſtands the art of building, performs ſuch work in maſonry as one would imagine muſt greatly ſurpaſs the ſtrength of a fly. With ſand, collected grain by grain, and glued together with a kind of cement much preferable to ours, ſhe erects a houſe for her family; a very ſimple one indeed, but extremely ſolid and commodious. It is divided within into ſeveral chambers or cabins, on the back of each other, without any communication between them. One general foldage, that is, if we may uſe the expreſſion, a wall of incloſure comprehends them all, and leaves no opening without. This wall muſt be broke before the apartments can be ſeen, and it is found to be as hard as a ſtone. Theſe neſts are very common on the fronts of houſes: they there reſemble little oval hillocks, of a different grey from that of the ſtone. The fly that is the architect of theſe buildings depoſits an egg in each chamber, and ſhuts up in it at the ſame time a ſtock of wax or *paſte*, which is the nouriſhment appropriated to her young.

Another fly, which may be called the *carpenter** bee, becauſe ſhe works in wood, likewiſe builds apartments for her family, but in a different taſte from that of the *maſon*. Sometimes ſhe diſtributes them into ſtages; ſometimes diſpoſes them in a ribble row. Cielings or partitions artfully made, ſeparate all theſe ſtages or chambers, and there is

* The *wood piercing* bee.

an

an egg depoſited in each of them, with the quantity of paſte neceſſary for the young.

Theſe various kinds of work require in general leſs ſkill and genius than labour and patience. There is a very different degree of art and ſagacity diſplayed in the neſt conſtructed by another fly with ſingle pieces of leaves only. This neſt is a real prodigy of induſtry. When it is taken to pieces, and narrowly examined in all its parts, one cannot conceive how a fly ſhould be able to cut them out, turn, and put them together with ſo much propriety and exactneſs. When viewed on the outſide, this neſt very much reſembles a tooth-pick caſe. The inſide is divided into ſeveral little cells, in the form of a thimble, ſet in one another as thimbles are in a tradeſman's ſhop. Every thimble conſiſts of ſeveral pieces, which are ſeparately cut from one leaf, and whoſe form, circumference, and proportions tally with the place each is intended to occupy. The ſame method is uſed with reſpect to the pieces that form the caſe or common cover. In a word, there is ſo much exactneſs, ſymmetry, uniformity, and ſkill in this little maſter-piece, that we ſhould not believe it to be the work of a fly, did we not know at what ſchool ſhe learnt the art of conſtructing it. We may naturally conjecture that each thimble is a lodging for a little one; but we could not have imagined that the paſte which the mother provides for it is almoſt liquid, and that the little cell, which is intirely compoſed of ſmall pieces of leaves, is notwithſtanding a veſſel ſo well cloſed up, that this paſte never ſpills, even when the veſſel is ſtooped.

It is not ſo much on their own account as for the ſake of their young, that the *republican* bees conſtruct theſe honey-combs, the order and proportions

tions are determined by the moſt exact rules of geometry. One part of the little cells they are compoſed of ſerves for cradles to the young; and as theſe latter are of three ſizes, ſo the bees form three orders of holes in the honey-combs. They bring food every day to their nurſlings, and by a ſingular attention proportion the nouriſhment to their age and ſtrength. They likewiſe take particular care always to maintain about them a degree of heat nearly equal, by gathering about their cells in cold days, and keeping at a diſtance from them when the weather is hot. Laſtly, when the time is come that the young have no farther need of nouriſhment, and are preparing themſelves for their metamorphoſis, they ſhut up their holes cloſe with a lid of wax. The inſtinct of the mother-bee in her choice of cells to depoſit her eggs in, is likewiſe very remarkable. We never ſee her lodge an egg of a male in the cell of a labourer, nor an egg of a labourer in the cell of a male.

The young of many ſpecies of flies are carnivorous, and feed only on living animals. Some of the mothers impriſon in their neſts little ſpiders; others little flies: others little worms, which they faſten to the walls of the cell, and range on one another like hoops. The young one devours ſucceſſively theſe unfortunate victims condemned to ſupply him with food, and when he has made an end of eating the laſt, he has no farther occaſion to be fed, and has then acquired his perfect growth.

Other flies are taught to lay their eggs in the bodies of living inſects, or in their neſts. Neither the agility of theſe inſects, nor the offenſive and defenſive arms they are provided with, nor the ſolidity or thickneſs of the walls of their apartments,

are

are capable of triumphing over the dexterity, courage, and vigilance of the *ichneumons* *.

The analogous proceedings of ſome other flies are ſtill more extraordinary. Some wait at the paſſage of the anus of horſes, and the moment it opens convey themſelves into the inteſtines, where they depoſit their eggs. Others enter the noſe of a ſheep, and lay them in the frontal ſinus. Another kind, ſtill more hardy, go through the naſal duct of the ſtag, deſcend to his palate, and lay their eggs in two fleſhy bags placed at the root of the tongue.

As there are ſome ſpecies that lay their eggs within living animals, ſo there is a much greater number that depoſit them in the interior part of vegetables. There is no part of them but ſerves for a retreat or ſuſtenance to one or more inſects. A fly pierces the leaf of the oak: ſhe cauſes a *gall-nut* to be formed in it, in the centre of which is lodged an egg. We have ſeen †, that this extraordinary egg grows like an animal. As it grows, it occaſions the nut to grow; the little one that is hatched from it, finds by this means a lodging and food accommodated to its nature. Another fly, by the help of an admirable ſaw, makes cells in the branches of a roſe-buſh, which ſhe diſpoſes in an uniform manner, and lays an egg in each of them.

CHAP. VI.

Continuation of the ſame ſubject.

BIRDS.

AMONG birds, the female is not alone charged with the labour; the male ſhares it with her. The ſimplicity of their architecture is admirable.

* This is the name that naturaliſts give to ſuch flies as depoſit their eggs in the bodies of living inſects. This name is taken from the *ichneumon*; a kind of rat in Egypt that deſtroys the eggs of the crocodile. † Part viii. chap. vi.

The neſt is hollow, and of a form nearly hemiſpherical, the better to concenter the heat. It is made with finer or coarſer materials, ſuch as are proper for a foundation and defence to the little edifice. It is lined within with feathers, hair, cotton, or other matters fit to furniſh a warm and ſoft bed to the young. What attention do they pay to the proper ſituation of the neſt, and to ſhelter it from rain and the inſults of animals? What aſſiduity, what conſtancy in ſitting! Obſerve likewiſe the precaution taken by the female to ſhift her eggs, that they may all receive an equal ſhare of warmth; and the inſtinct which induces her to pierce them, in order to facilitate the hatching of the young. Are they hatched? What freſh cares occupy the parents, to provide them with ſuitable nouriſhment! With what prudence, what equality do they diſtribute it! What vigilance concerning every thing that may injure the little family! What courage in defending it! What pains, what ſolicitude, what ſagacity in their manner of breeding them under their wings, of guiding, exciting, and preparing them for flight!

CHAP. VII.

Farther continuation of the ſame ſubject.

QUADRUPEDS.

THEY ſuckle their young; lick them with their tongues, and by this means cure their wounds, particularly that of the navel ſtring. They tranſport them on occaſion from one place to another. They gather them together, protect, conduct them. Amongſt the carnivorous ſpecies, what pains do not the dams take to furniſh their little ones with meat! What art do they uſe in training them up to ruſh upon their prey, play with it, and tear it in pieces!

What

What variety do not the different ſpecies of quadrupeds offer to our view in theſe reſpects! and how ſhall we be able to delineate them all!

CHAP. VIII.

Reflections on the love of animals towards their young.

THIS love is a very active principle, which equals, and even ſometimes ſurpaſſes in ſtrength that which leads every individual to provide for its own preſervation. We ſee fathers and mothers undergo ſevere labour, and expoſe themſelves to the greateſt dangers, in order to procure food for their young, or to ſuccour them in their neceſſity. We cannot read without emotion the ſtory of a bitch, that, whilſt they were diſſecting her, endeavoured to lick her puppies, as though they charmed away her ſufferings, and when they were removed at a diſtance from her, cried in a plaintive manner.

Is it not probable that Nature has intereſted the affection of the mothers, for the better ſecurity of their young, by diſpoſing things in ſuch a manner that the young become to them a ſource of agreeable ſenſations and real advantages?

Some facts ſeem to confirm this conjecture. The action of giving ſuck is the moſt important of all for the young, ſince their life immediately depends upon it. The breaſts are made with ſuch art, that the ſuction and preſſure of the young, excite in the nerves that diſtribute the milk, a ſlight ſhaking, a gentle commotion, which is attended with a ſenſe of pleaſure. This ſenſe preſerves the natural affection of the mother, if it is not one of its principal cauſes. The ſame may be ſaid of the act of licking, which beſides is reciprocal. The mothers are ſometimes incommoded by the abundance of their milk; the young relieve them by ſucking.

This is not ſo diſcernible in other animals as it is amongſt quadrupeds; but perhaps that may be owing to our not having turned our inquiries that way. We may however obſerve, with regard to the young of birds, and chickens in particular, that they cauſe the hand that is laid upon them to feel a kind of univerſal trembling, more ſenſible in all appearance to the hen, whoſe belly, which at that time is ſtripped of the feathers, is endued with a very delicate feeling. This trembling ſhakes lightly the nervous papillæ, and excites in them little vibrations, whence reſults a moderate tickling, the cauſe of pleaſure. That gentle warmth which is reciprocally communicated by the mother and her young, ſhould likewiſe be taken here into the account.

Incubation ſeems a myſtery very difficult to penetrate. We cannot conceive what ſhould retain a bird for whole weeks on her eggs, that has never before ſat, and conſequently cannot have experienced that theſe eggs would be productive of young ones. We may however ſurmiſe, that this may be imputed to the ſame motive as hunger and thirſt, or the deſire of propagating the ſpecies, whoſe cauſes principally reſide in the conſtitution of the animal, or in the inteſtine motion of certain humours. One ſign that incubation is only the effect of natural neceſſity, is, that we ſee hens ſitting on pieces of chalk, ſmall ſtones, and eggs of a very different ſpecies from their own. Inſtinct is, it ſeems, more certain in its diſcernment.

With regard to the conſtruction of the neſt, it has perhaps a ſecret and phyſical reference to the occaſion of laying eggs, by virtue of which the female is excited to labour. The male may be ſo induced by ſome other analogous occaſion, or by imitation. And with reſpect to the architecture, as it is uniform in every ſpecies, that may depend ultimately on

on the form of the bird's body, and on the ſtructure and proportions of his bill and feet, which are the inſtruments relative to this architecture.

The inadvertency of hens that ſit on pieces of chalk, or on eggs of a ſpecies different from their own, proves that Nature has left to her agent a certain latitude, within the limits of which (beſides the primary end, that cannot fail to be obtained by theſe means) are likewiſe compriſed particular or ſecondary ends.

The education of their young is the principal end of the affection of mothers for them. As ſoon as they are in a condition to provide for themſelves, this affection not only ceaſes, but likewiſe changes into hatred: the mothers drive them away, and thus oblige them to make uſe of the means given them to ſubſiſt by their own endeavours.

It may perhaps be for a contrary reaſon that ſome mothers deſtroy ſuch of their young as are not completely formed, or that are in a ſituation incompatible with that requiſite for bringing them up. The young of bees muſt be bred, grow, and transform themſelves in cells horizontally diſpoſed: Does there happen any change in their poſition? The bees ſnatch their young from theſe cells, and put them to death.

Experiments concerning this, if made in the ſpirit of theſe reflections, would ſet it in a clear light, and be productive of new ideas.

CHAP. IX.

Of the nature and diſpoſition of animals.

NATURE has given to every animal a *character* peculiar to it, and which manifeſts itſelf without by a particular inclination to certain acts, by

the air, look, gait, and in a word by every exterior habit or the whole of the animal. This character is, to uſe the expreſſion, in *pſychology*, what the generical or ſpecific difference is in *phyſics*; but the relations are quite otherwiſe eaſy to fix in the latter than in the former; undoubtedly becauſe we fail to make thoſe curious and profound reſearches neceſſary for elucidating a ſubject of this nature. The courage of the lion, the fierceneſs of the tyger, the voraciouſneſs of the wolf, the ſtatelineſs of the ſteed, the gluttony of the hog, the ſtupidity of the aſs, the docility of the dog, the malice of the ape, the craftineſs of the fox, the ſubtilty of the cat, the gentleneſs of the lamb, the indolence of the ſluggard, the timidity of the hare, the vivacity of the ſquirrel, are examples to which we may refer many ſpecies of different claſſes.

Theſe various characters are ſuſceptible of modifications. We tame, to a certain degree, the fierceſt of them: the bear and the lion may acquire ſome docility, and ſubmit to the direction of a perſon equally ſkilful and courageous. But their nature, which cannot be deſtroyed, always appears again; the bear remains a bear, and the lion ceaſes not to be a lion.

The poſſibility of inclining and modifying the diſpoſition of animals to a particular point, and of cauſing them to receive new impreſſions, is the reſult of that inſtinct which prompts them to ſeek for what is neceſſary to their preſervation, and on the contrary to avoid what may hurt them. Hunger and fear are the two grand incentives which determine them, and men know how to put them in motion.

Let us here remark the attention of the AUTHOR of Nature to place at a diſtance from us the fierce animals, and to endue with ſociable qualities

ſuch

ſuch as are appointed to live near us. His WISDOM has concealed from the latter the knowledge of their own ſtrength, and a numerous drove of oxen ſubmit to the ſtroke of a child.

CHAP. X.

Of animal ſocieties in general.

THE diſtinction of animals into *ſolitary* and *ſociable* is very great. We may diſtribute the ſocieties of animals into two general claſſes; viz. into ſocieties *improperly ſo called*, or thoſe whoſe individuals do not labour in concert on the ſame works; and ſocieties *properly ſo called*, or thoſe whoſe individuals labour in common.

Large and ſmall cattle, divers ſpecies of domeſtic birds and birds of paſſage, the ſpecies of fiſhes that ſwim in ſhoals, ſeveral kinds of inſects that collect themſelves together in the ſame place, ſuch as vine-fretters, gall-inſects, &c. furniſh examples of ſocieties of the firſt claſs.

The ſocieties of the ſecond claſs are obſerved in ſome ſpecies of caterpillars and worms, and among bees, waſps, drones, ants, beavers, &c.

CHAP. XI.

Societies improperly ſo called.

THESE ſocieties are formed of the union of ſeveral individuals, which their neceſſities or mutual advantages bring together into the ſame place. But whilſt in ſocieties properly ſo called every individual labours for the public good; in ſocieties improperly ſo ſtyled, every individual acts principally for himſelf, and it is only in certain circumſtances that

that all the individuals concur in promoting the common ſafety or intereſt.

A drove of oxen is grazing in a meadow: a wolf appears: they immediately form into a battalion, and preſent their horns to the enemy. This warlike diſpoſition diſconcerts him, and obliges him to retire.

In winter, hinds and young ſtags aſſemble in *herds*, in ſo much the more numerous companies as the ſeaſon happens to prove ſevere. They warm each other with their breath. In the ſpring they ſeparate themſelves, the hinds concealing themſelves in order to bring forth. The young harts remain together, love to walk in company, and are only parted by neceſſity.

Sheep that are expoſed to the ſultry heat of the dog-days in an open plain, keep near each other, ſo that their heads touch; they hold them inclined towards the earth, and ſnuff up the freſh air which comes from beneath them.

Wild ducks, that are accuſtomed to change their climate, range themſelves in their flight in the form of a wedge, or an inverted V, that they may cleave the air with the greater eaſe. The duck at the extreme point leads the flight, and cleaves the air firſt of all. After a certain time he is relieved by another, the ſecond in his turn by a third, &c. In this manner each bears a ſhare in every laborious part of this office.

Vine-fretters aſſemble in great numbers on plants: we have but an imperfect knowledge of all the advantages they derive from this kind of ſociety; but we may reaſonably conjecture, that the re-iterated punctures of the greateſt number of theſe inſects, draw proportionably a greater quantity of nutritious juices from that part of the plant on which they are fixed. This appears more evidently from the formation

formation of *bladders* on the elm. When they are opened, they are found to be full of vine-fretters. Theſe remarkable tumours are in fact occaſioned by their punctures. At the ſame time that each of theſe inſects extracts the juice which contributes to its growth, it promotes the production of the bladder, which is to provide all of them with lodging and ſuſtenance.

CHAP. XII.

Reflections.

ANIMALS to whom the company of their own kind is uſeful, have been rendered fit for this ſort of commerce. And if the AUTHOR of Nature had man in view with reſpect to this particular, as we may without pride ſuppoſe, the means will be found to correſpond perfectly well with the end. In effect, how many embarraſſments and inconveniencies would have accompanied the divers ſervices we deduce from domeſtic animals, if individuals of the ſame ſpecies had not power to cohabit together!

The ſpirit of ſociety is not altogether limited to individuals of the ſame ſpecies, but extends likewiſe in a certain degree to thoſe of different ſpecies, and from thence man alſo derives ſome advantage. The cuſtom of ſeeing each other, of eating their meals in common, of repoſing under the ſame roof, accounts for or confirms the natural diſpoſition of domeſtic animals to live in ſociety. The connections which reſult from it become conſequently ſo much the ſtronger, as they began earlier or nearer to their birth. Thus animals that are not appointed to live together, may notwithſtanding form a ſort of ſociety: the natural inclination each of them has to

live with thoſe of a like kind, is ſuſceptible of modification or extenſion.

Every individual knows his like; thoſe of the ſame ſociety likewiſe know them. It is obſervable, that if ſtrange fowls are brought into a poultry-yard, thoſe of the place will perſecute them, till cohabitation has made them members of the ſociety.

The outſide of the body exhibits divers characters, by means of which individuals of the ſame ſociety may know each other, and diſtinguiſh ſtrange individuals. But among theſe phyſical characters there may be ſome *mixed* ones, or ſuch as belong as much to the ſoul as the body, which the animals of the claſs we are treating of are capable of ſeizing; ſuch are the air, poſture, gait, &c. The individuals of that ſpecies which are not yet become familiar in their new habitation, ſeem fearful or embarraſſed; this fear or embarraſſment detects them, and excites or encourages others to attack them.

That kind of ſociety in which domeſtic animals live gives room for a remarkable obſervation; the young lamb diſtinguiſhes her mother from amongſt 3 or 400 ſheep, although there does not appear to be any ſenſible difference betwixt them.

Explanation of this fact. Thoſe objects which to us ſeem perfectly alike, have often real differences between them, which we do not perceive, either becauſe their ſmalneſs conceals them from our ſight, or becauſe they are of ſuch a nature as not to attract our attention. The lamb, that is more intereſted in the diſcovery of theſe differences, actually diſcerns them; and this is ſufficient for the ſolution of the caſe, without any neceſſity for our having recourſe to latent principles. If however we are inclined to add to this method, that whereby the dog knows his maſter in the midſt of a great multitude, I mean by ſmelling, there is nothing in that but what

what is very natural. We may farther admit differences between the bleating of one ſheep and that of another; differences which though they are indiſcernible by us, nevertheleſs ſtrike the ear of the lamb.

CHAP. XIII.

Birds of paſſage.

NOTHING is more wonderful than thoſe legions of flying creatures, that at a ſtipulated time paſs from one to other very remote countries. What inſtinct aſſembles them? What compaſs directs them? What chart points out their way? We preſently conceive that the change of the ſeaſon, and the want of ſuitable nouriſhment, advertiſe theſe different ſpecies of birds to ſhift their abode. But whence did they learn that they ſhould meet with in other regions a climate and aliment proper for them? In order to be able to anſwer theſe queſtions, and all ſuch as may be aſked on this intereſting ſubject, we ſhould carefully examine every circumſtance that attends the marches of theſe birds. The degree of cold or heat that accelerates or retards them, deſerves to be particularly attended to; for there is no room to doubt that they are moſt of all influenced by this. There is perhaps a ſecret relation between the temperature which ſuits with certain ſpecies, and that which is neceſſary for the production of the food that nouriſhes them.

The winds ſeem to have a great influence over the emigrations of birds. The hiſtory of theſe emigrations is eſſentially connected with meteorological obſervations, and ſuppoſes them. It would undoubtedly be much eaſier to aſſign a reaſon, why the birds in queſtion fly in numerous ſquadrons

than

than ſeparate or apart. They are by this means leſs liable to become the ſport of winds. But this advantage is not probably the only one that procures to them the ſtate of ſociety. We have not carried our inquiries deep enough into theſe different ſpecies of birds and fiſhes of paſſage.

CHAP. XIV.

Herrings.

HERRINGS emigrate in great companies, from the North pole towards the coaſts of England and Holland. Theſe emigrations ſeem to be occaſioned by whales and other great fiſhes, which the frozen ſeas include within their boſom, and which purſue the herring. Theſe ſea-monſters ſwallow at once whole tuns of them. They often chaſe their prey as far as the coaſt of England and Scotland. Herrings multiply exceſſively, and they are perhaps of all fiſhes thoſe that multiply the moſt. They ſeem to be a manna provided by PROVIDENCE for a great number of fiſhes and ſea birds. If the ſpecies of herrings would preſerve themſelves, they muſt know how to elude the purſuit of their enemies.

Herrings arrive at the coaſts of England and Scotland about the beginning of June. Their numerous legions then form themſelves into ſeveral diviſions. Some ſteer their courſe towards the eaſt, others towards the weſt. After having ſailed ſome time, the different companies divide themſelves again, and paſs over the various latitudes of the Britiſh and German ſeas, afterwards re-unite themſelves, and at length diſappear at the end of ſome months. Many thouſands of the Dutch are employed every year in the herring-fiſhery; by this inſtance alone we may judge of the aſtoniſhing multiplication of this fiſh.

CHAP.

CHAP. XV.

Rats of paſſage.

THESE rats, which are peculiar to the moſt northern parts of Europe, appear from time to time in ſuch prodigious numbers in the fields of Norway and Lapland, that the inhabitants imagine they fall from the ſky. A celebrated naturaliſt *, who has beſtowed on them the attention they deſerved, has acknowledged that theſe rats perform their emigration every eighteen or twenty years. They iſſue from their dwelling places, and take the field. In their way, they form a track of paths or furrows in the ground of the depth of two fingers, and which is ſometimes ſeveral toiſes in width. But what is very extraordinary in theſe emigrations is, that the rats conſtantly march in a ſtrait line, without ever turning aſide except on meeting with ſome impenetrable obſtacle. So that when they happen to be ſtopped in their progreſs by a rock, they immediately attempt to pierce through it, but finding that impracticable, they go round it, and regain the right line on the other ſide. If they meet with a heap of hay or ſtraw, they pierce through it, always in a right line. A lake never ſtops them; they likewiſe croſs, or attempt to croſs it in a right line, and if they find a bark, or any other building in their paſſage, they inſtantly climb upon it, croſs over it, and paſs down on the oppoſite ſide in a line parallel to that by which they aſcended it.

* Mr. Linnæus.

CHAP. XVI.

Societies properly ſo called.

AMONG ſocieties *improperly ſo called*, ſome depend on chance, or on the agency of men, if not altogether, at leaſt in part. It is ſo with reſpect to ſocieties *properly ſo called*. They do not owe their origin to any human act, nor to any ſtrange circumſtance, but they ariſe ſolely from nature. The members that compoſe them are not only united by common neceſſities or benefit, and that often for a very ſhort time; they are ſo by a much ſtronger tie, which ſubſiſts to the death of the animal, or at leaſt during a conſiderable part of its life; I mean the natural preſervation of the individual, or that of its family. Both the one and the other are neceſſarily attached to the ſtate of ſociety. It is for this great end that theſe different ſpecies of ſociable animals have been inſtructed to labour in common on works ſo worthy of admiration.

Societies *properly ſo called* may be divided into two claſſes; the firſt comprehends thoſe *whoſe principal end is limited to the preſervation of individuals*; the ſecond, thoſe *whoſe ſcope is, the preſervation of individuals, and education of the young.*

Several ſpecies of caterpillars and ſome ſpecies of worms belong to the former of theſe two claſſes; ants, waſps, bees, beavers, &c. to the ſecond.

The firſt claſs will have under it two principal ſorts; one of which will comprehend *temporary* ſocieties; the other, ſocieties *for life.*

CHAP.

CHAP. XVII.

Common caterpillars.

A Butterfly depoſits her eggs, about the middle of ſummer, on the leaf of a plum tree; the number of theſe eggs is three or four hundred. After ſome days, there iſſues from each of them a very ſmall caterpillar. They are ſo far from diſperſing themſelves on the adjoining leaves, that they all continue together on that whereon they firſt received their being: the ſame ſpirit of ſociety unites them. They apply themſelves immediately in concert to the ſpinning of a web, which at firſt is very thin, but they afterwards make it ſtronger by gradually adding new threads to it. This web is a real tent ſpread upon the leaf, under which the young caterpillars ſhelter themſelves. As they increaſe in bulk, they extend their lodging by freſh layers of leaves and ſilk. The ſpaces contained between theſe layers are apartments, all of which communicate by doors made on purpoſe. In this neſt they paſs the winter, placed near each other, without motion, till the returning ſpring enlivens them, and invites them to brouze on the ſprouting leaves. Laſtly, towards the month of May, the ſociety is diſſolved; every caterpillar ſeparates from his companion, and ſpends the remainder of his life in ſolitude. Being then become ſtronger, a ſtate of ſociety is no longer neceſſary for them, they have no need of one common habitation.

This ſlight ſummary of the hiſtory of that called the *common* caterpillar, as being the ſpecies we moſt commonly meet with, affords an idea of *temporary* ſocieties, whoſe primary and direct end is the preſervation of individuals.

CHAP.

CHAP. XVIII.

Proceſſionary caterpillars.

THESE caterpillars, that live on the oak, and whoſe ſocieties are much more numerous than thoſe of the *common*, are very ſingular in their proceedings. They ſet out from their neſt at ſun-ſet, and march in proceſſion, under the conduct of a chief, whoſe motions they follow. The ranks are at firſt compoſed only of one caterpillar, afterwards of two, three, four, and ſometimes more. The chief has nothing in him that may diſtinguiſh him from the reſt, but by being the firſt, and that he is not conſtantly, becauſe every other caterpillar may in his turn occupy the ſame place. After having taken their repaſt on the leaves around them, they return to their neſt in the ſame order; and this continues during the whole life of the caterpillar. When they have arrived to their full growth, each forms for himſelf a cone, where it is transformed into a chryſalis, and afterwards aſſumes the form of a butterfly. Theſe metamorphoſes cauſe a new kind of life to ſucceed to the ſtate of ſociety, which is very different from the primitive one.

This is an example of ſocieties *for life*, whoſe principal end is the preſervation of individuals.

CHAP. XIX.

Remarkable procedure of caterpillars that live in ſociety.

THERE are ſeveral kinds of theſe caterpillars that are true republicans, and whoſe diſcipline, manners, and genius, diverſify them as much as thoſe

thoſe of different people. Some of them, like ſavages, make themſelves hammocks, in which they take their meals, and even paſs their whole lives, and transform themſelves. Others live like the Arabs and Tartars, in tents, which they erect in the meadows; and when they have conſumed all the herbs that grew about them, they go away and pitch their camp elſewhere.

The neſts which the republican caterpillars make for themſelves are perfect retreats; they are ſcreened in them from the injuries of the air, and are all cloſely ſhut up in times of inaction or idleneſs. But they go out at certain hours to ſeek their nouriſhment. They feed on the leaves which ſurround them, which they conſume one after another. They often go to a great diſtance from their dwelling, and by different turnings. However, they can always find it again, and betake themſelves to it when they have occaſion. They are not guided with that certainty in their marches by ſight; that is ſufficiently proved. Nature has provided them with a method for regaining their lodging, which anſwers exactly to that uſed by THESEUS for fetching his dear ARIADNE out of the labyrinth. We pave our ways; our caterpillars line theirs with tapeſtry. They never walk but on ſilk carpets. All the paths that lead to their neſt are covered with ſilk threads. Theſe threads form tracks of a gloſſy white, which are at leaſt two or three lines in width. By purſuing theſe tracks in a row, they never loſe their way, how intricate ſoever the turnings and windings of their paſſage may be. By putting a finger on the track, we ſhould interſect the path, and throw the caterpillars into the greateſt perplexity. They ſtop on a ſudden at this place, and expreſs all the ſigns of fear and diſtruſt. Their march is ſuſpended, till ſome caterpillar, more bold

or impatient than the reſt, croſſes over the ſpoiled path. The thread ſhe ſpreads in croſſing ſerves as a bridge for the next to paſs over. This in paſſing ſpreads another thread; a third another, &c. and thus the way is ſoon repaired.

The induſtrious proceedings of inſects, and animals in general, eaſily ſtrike our imagination. We are pleaſed with viewing and reaſoning upon them. There is a great difference between the method of the republican caterpillars and that of Theſeus. They do not ſpread a carpet over their paths, to prevent their miſſing their way; but they do not miſs their way becauſe they ſpread ſuch a carpet. They ſpin continually, becauſe they have always occaſion to evacuate the ſilky matter, which their nouriſhment produces again, and which is incloſed in their inteſtines. By ſatisfying this want, they are aſſured of being in the right path, without attending to it, and even the more on that very account. The conſtruction of the neſt is likewiſe connected with this want. Its architecture is adapted to the form of the animal, to the ſtructure and exerciſe of his organs, and to his particular circumſtances. We have here taken a tranſient view of one of the moſt general and philoſophical principles that can poſſibly be formed concerning the operations of brutes: we will reſume it.

CHAP. XX.

Queſtion.

MAY not the ſocieties we have juſt treated of owe their origin to that circumſtance which is common to the caterpillars that compoſe them, to wit, their being produced from eggs depoſited near each other?

There

There is no room to doubt it; ſince this circumſtance is to be found in many ſpecies of caterpillars, which however do not labour in concert on the ſame work. Silk-worms are a very familiar example of this. It is true, they remain voluntarily aſſembled in the ſame place; a diſpoſition which is very advantageous to us; but the individuals of many other ſpecies diſperſe after their birth never to unite again. Spiders newly hatched begin by ſpinning in common, and finiſh in a ſhort time by devouring each other.

We are then obliged here to have recourſe to this principle or inſtinct, by virtue whereof every animal acts in a manner conformable to his welfare or deſtination.

There might nevertheleſs be a curious experiment attempted on this ſubject; and that is, to diſperſe the eggs of the butterfly of the common caterpillar, let the caterpillars hatched from them live ſome time in ſolitude, and afterwards aſſemble them together. We ſhould aſcertain by this method the influence of the circumſtance we ſpeak of. We might likewiſe endeavour to form ſocieties of individuals of different ſpecies, and to unite ſeveral ſocieties of the ſame ſpecies into one body, &c.

CHAP. XXI.

Societies that have for their principal end the education of their young.

AS caterpillars do not engender till they arrive at the ſtate of the butterfly; they do not concern themſelves, in their ſocieties, with the training up of young. Their own preſervation is the ſole end of their labour. The moſt perfect equality reigns amongſt them, no diſtinction of ſex, and ſcarce any

diſtinction of ſize. They aſſemble together; all bear an equal ſhare in their labour; all properly ſpeaking compoſe but one family, deſcended from the ſame parent.

The ſocieties of ants, waſps, and bees are formed on very different models. Theſe are republics, that conſiſt of three orders of citizens, which are diſtinguiſhed by their number, ſize, figure, and ſex. The females, which are commonly the largeſt, and not ſo numerous as the others, hold the firſt rank; the males, which are not ſo advantageouſly ſhaped, but are in much greater numbers, form the ſecond rank; the *mules* or *neuters*, that are of no ſex, always very ſmall, and more numerous, compoſe the third order.

CHAP. XXII.

Ants.

HOW aſtoniſhing muſt the activity of theſe laborious inſects be, by which they are enabled to collect the materials neceſſary for the conſtruction of their neſt! Behold their ſagacity in uniting together, and aſſiſting each other in ſcooping out the earth, in order to tranſport to their habitation bits of herbs, ſtraw, ſcraps of wood, and other bodies of the like kind, which they employ in their work. They ſeem only to pile it up in heaps at random, but under this apparent confuſion is couched art and deſign, which is perceived upon a ſtricter examination. Under this little heap, of which their lodging conſiſts, and whoſe form facilitates the paſſage of the water, are diſcovered galleries, which communicate with each other, reſembling the ſtreets of a little city. We are particularly ſtruck with the continual ſolicitude of ants for their nurſlings, with the care they tak

take to convey them in proper time from one place to another, their nouriſhing them, and cauſing them to ſhun every thing that may prove hurtful to them. One cannot but admire the readineſs with which they withdraw from danger, and the courage they ſhew in defending them. An ant has been ſeen, after being cut aſunder in the middle, to tranſport eight or ten of its nurſlings one after another. Laſtly, they likewiſe take care to preſerve about them a proper degree of warmth.

They ſeek their proviſions and aliment at a great diſtance from their abode. Various paths, which are often very winding and intricate, terminate at their neſt. The ants paſs over them in rows, without ever miſſing their way, any more than the republican caterpillars. Like the latter, they leave tracks where-ever they paſs. Theſe are not diſcernible to the eye; they are much more ſenſible to the ſmell; and it is well known that ants have a very penetrating one. However, if we draw a finger ſeveral times backwards and forwards along the wall by which the ants paſs and repaſs up and down in rows, they will be ſtopped on a ſudden in their march, and it will afford ſome amuſement to obſerve the perplexity they are in. It will happen in the ſame manner with regard to the proceſſions of theſe ants, as has been before related concerning thoſe of the caterpillars.

The foreſight of ants has been greatly celebrated. Near three thouſand years ago it was remarked, that they amaſſed proviſions for the winter; and were ſkilful in building magazines for containing the grain they had collected during the fine ſeaſon. It would ſeem that theſe magazines muſt be altogether uſeleſs to them, inaſmuch as they ſleep during the whole winter, like dormice, and many other animals. A ſmall degree of cold would be ſufficient

to benumb them. We may conclude thence that they have no uſe for ſuch pretended magazines; and conſequently do not build any. The corn they convey with ſo much activity to their dwelling, is by no means intended by them for food; but conſiſts only in ſimple materials, which contribute to the conſtruction of their edifice, in the ſame manner as little bits of wood, ſtraw, &c. which they bring thither for that purpoſe. The facts then which have been atteſted by the moſt venerable antiquity, merit likewiſe the regard of the curious obſerver, and the philoſopher's logic.

CHAP. XXIII.

Waſps.

A Republic of waſps, how numerous ſoever it be, owes its birth to a ſingle mother. This, without any aſſiſtance, pierces the earth in the ſpring, and bores a hole in it, wherein ſhe forms a little cake, which is an aſſemblage of hexagonal cells, whoſe apertures are turned perpendicularly downwards. In each cell ſhe depoſits a *mule* egg, *i. e.* that of a labouring waſp; for the *mules* among waſps, as well as among bees, are conſigned to the moſt laborious employment; it is on that account neceſſary for them to be produced firſt, that they may comfort and aſſiſt the mother in her labour. This they do in effect, as ſoon as they have by her indefatigable care arrived from the ſtate of worm to that of a fly. They apply themſelves to the forming of new cakes, which are joined with the others by little pillars, like columns.

Eggs of females, males, and mules or neuters are laid in the cells of theſe cakes by the parent waſp, and the young that are hatched from the

are brought up by the labourers. After they are become flies, the females and neuters apply themſelves to the extending the limits of the riſing city; the mules bear no part in this work; their principal office being to fecundate the young females. They are nevertheleſs appointed, in a certain degree, to provide for the ſubſiſtence of the tender nurſlings. Thus this little republic increaſes daily; and towards the latter end of the ſummer becomes a great city, peopled with many thouſands of inhabitants. The waſp-hive is commonly at that time fifteen or ſixteen inches long, and about twelve or thirteen inches in width. The cakes are covered over with a thick foldage of the ſame matter as they are compoſed of; to wit, a kind of paper made of rotten wood; and this cover is as it were the incloſure of the city.

CHAP. XXIV.

Bees.

THE government of the bees more nearly reſembles the monarchical than the republican. In that, a ſingle bee governs the whole. This bee is not only the queen of the people, but is likewiſe their mother in the ſtricteſt ſenſe. Among thirty or thirty-five thouſand bees, of which a hive frequently conſiſts, the queen is the only one that breeds. It is to this prerogative, which is a more real one than many of thoſe which diſtinguiſh ſovereigns, that ſhe is indebted for the extreme affection her ſubjects bear her. She is almoſt continually attended by a circle of bees, who are ſolely employed in endeavouring to render themſelves ſerviceable to her. Some preſent her with honey, others paſs their trunk lightly to and fro on her

body, in order to remove from it any thing that may be offenſive. When ſhe walks, thoſe that are in her paſſage range themſelves in a proper manner to make way for her. They either know, or ſeem to know, that this procedure has an important object in view, that of augmenting the number of citizens.

Indeed ſhe is at that time in ſearch of proper cells for the reception of her eggs. Theſe cells are like thoſe of the waſps, of an hexagonal form, but their lower part is made with much greater art: inſtead of being nearly flat, it is pyramidal, and compoſed of three even and ſimilar lozenges, ſo proportioned, that they unite in them theſe two remarkable properties; the firſt, that of giving the greateſt capacity to the cell; and the ſecond, that it requires the leſs matter for its conſtruction.

The architecture of the bees likewiſe ſurpaſſes that of the waſps in the diſpoſition of the combs: the latter have only one range of cells; whereas the management of the former is much more advantageous, each comb has a double range of apartments. They bear againſt each other at the bottom, ſo that the aperture of thoſe of one range faces, on the oppoſite ſide, that towards which thoſe of the other range are turned. Their axis is parallel to the horizon, and the comb they compoſe is perpendicular to it. This poſition, which is directly contrary to that of the waſps, is determined by particular circumſtances, and the preſervation of the young depends upon it.

The neuters, or *labouring bees*, form theſe combs, in which there appears ſo excellent a geometry. They collect the matter for them from flowers. The wax is made of the duſt of the ſtamina. They prepare this duſt, and digeſt it. They make little maſſes of it in their hives, either for the contributing to the

the conſtruction of new combs, or to ſerve them for food.

Whilſt one diviſion of the bees are employed in collecting the matter of the wax, and in preparing and filling the magazines with it, others are buſied in different labours. Some work this wax and build the cells with it; others poliſh and perfect the work; whilſt others reap a freſh harveſt from the flowers, by the honey they extract from them; which they afterwards depoſit in the cells, for the neceſſities of each day, and thoſe of the inclement ſeaſon. Others cover with a lid of wax the cells that contain the honey, intended to be preſerved for the enſuing winter; a precaution which prevents any alteration in it. Others feed the young. Some are employed in fixing a wax lid to the cells of ſuch as are about to metamorphoſe themſelves, that they may do it with the greater certainty. Others cloſe, with a kind of pitch, the ſmalleſt crevices in the hive, through which the air or ſmall inſects might gain admittance. And others, in the laſt place, carry out the carcaſes, which might infect the hive by their corruption: ſuch as are too large to be removed they cover with a thick layer of wax, or a kind of gum, under which they may putrify without cauſing any inconvenience.

In order to facilitate all theſe different works, the labourers take care to leave diſtances between the combs, that are like ſo many ſtreets, whoſe width is proportioned to the ſize of the bees; they are likewiſe ſkilful in contriving doors to each of the combs, by means of which they avoid going round about.

The queen animates the labourers by her preſence, which is more literally true than is commonly imagined. If a ſwarm be divided, that part which is deprived of the mother will periſh, with-

out conſtructing the leaſt cell; whilſt that part which is governed by the mother will repleniſh the hive with combs and proviſions of every kind.

The labour of the bees is generally in proportion to the number of eggs the mother is to lay. So that the greater her fecundity is, the more numerous will be the combs that are formed by the bees.

It would notwithſtanding be in vain to attempt to induce the neuters to make more combs, by introducing ſeveral mothers into the hives; for the ſupenumerary mothers would be preſently put to death. The conſtitution of the ſociety admits of no more than one.

The males, which are infinitely fewer in number than the neuters, but however abundantly numerous for a ſingle female, bear no part in what is tranſacted in the hive; their whole occupation is confined to fecundation only, and they cannot betake themſelves to that without ſome degree of pains: the queen muſt make the firſt advances, and excite, by reiterated careſſes, the favourite on whom her choice happens to fall. We have ſeen elſewhere*, that this inverſion of the general order is founded on very wiſe reaſons. The males are nouriſhed and provided for till about the month of Auguſt, at which time, being found to be uſeleſs and even burdenſome to the community, the neuters exterminate them intirely. They are apprehenſive, that were they to preſerve them alive, they themſelves would periſh with hunger during the winter.

However, at the return of ſpring, male bees appear again in the hive, and even ſeveral females may be diſcovered among them, and the number of neuters likewiſe increaſes daily. The extreme fecun-

* Part VIII. chap. 7.

dity

dity of the mother occaſions this numerous off-ſpring.

Laſtly, there iſſues from the hive one or more ſwarms, each of which have a queen at their head. Theſe are colonies which go in ſearch of an eſtabliſhment elſewhere, which they are not able to find in the metropolis, being overcharged with inhabitants.

CHAP. XXV.

Continuation of the ſame ſubject.

Thoughts on the policy of the bees.

THE ſight of a bee-hive is certainly one of the fineſt that can offer itſelf to the eyes of an obſerver. There appears in it an aſtoniſhing air of grandeur. One can never be weary of contemplating theſe workſhops, where thouſands of labourers are conſtantly employed in different works. We are ſtruck in a particular manner with the regularity and geometrical exactneſs of their works; as we likewiſe are at the ſight of their magazines, which are repleniſhed with every thing neceſſary for the ſupport of the ſociety during the rigorous ſeaſon. We likewiſe ſtop with pleaſure to behold the young ones in their cradles, and to obſerve the tender care of their nurſing mothers towards them.

But what chiefly attracts the attention of every one is the queen; the ſlowneſs, I had almoſt ſaid gravity of her march, her ſtature, which is a more advantageous one than that of the other bees, and, above all, the various homage paid her by the reſt, characteriſe her in a diſtinguiſhing manner. We can ſcarce believe what our eyes are witneſſes of, on obſerving the regard and aſſiduities of the neuters

for this beloved queen. But our amazement is greatly heightened when we ſee theſe laborious active inſects intirely ceaſe from their labour, and ſuffer themſelves to periſh, as ſoon as they are deprived of their ſovereign.

By what ſecret engagement, by what law ſuperior to that whereby each individual provides for its own preſervation, are the bees attached to their queen in ſuch a degree, as abſolutely to neglect the care of their own lives, when they happen to be ſeparated from her? This tie, this law, ſeems to be nothing more than the grand principle of the preſervation of the ſpecies: the neuters do not engender; but they know that the queen enjoys that faculty: they conſtruct thoſe cells, whoſe proportions we ſo much admire, for the reception of the eggs ſhe is ready to lay. Nature has intruſted them as much with regard to the young that is to be hatched from them, as ſhe has the mothers of other animals in favour of their offspring.

But it will be aſked further, how the mere preſence of the queen can excite the bees to their labour, engage ſome to erect cells, others to collect and amaſs wax, and others to gather honey, &c.?

May not this be the effect of a certain impreſſion purely phyſical? May not the eggs which the body of the parent bee is full of, affect the reſt by means of the ſmell, or of ſome other ſenſe unknown to us?

Be this conjecture as it may, we are not to ſuppoſe that the preſence of the queen is capable of making different impreſſions on different bees, by determining ſome to conſtruct the cells, others to ſtore up the wax, and others the honey, &c. The impreſſion in queſtion is one, it prompts the bees to labour; but this labour is different according to the particular circumſtances wherein each bee is placed;

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for example, a bee goes out from the hive; there is no room to think that this is with a fixed deſign of gathering wax rather than honey; but ſhe meets with a flower that abounds with the duſt of the ſtamina, and affords but little honey; therefore ſhe loads herſelf with the matter for the wax. We muſt alſo remark that this crop is principally reaped in the morning. At that time the fine powder of the ſtamina is not dried up by the heat of the ſun, it preſerves a certain humidity which connects the grains of it, and thus renders the collecting and tranſporting it more eaſy. The honey, on the contrary, being a juice which exſudes from the flowers by the action of the ſun, they afford but little of it in the morning; the middle of the day is the moſt favourable time for this kind of harveſt; conſequently we ſee very few bees at that time return to the hive loaded with wax, the greateſt part of them bringing honey.

But how comes it to paſs, that the bees, when deprived of their mother, ſuffer themſelves to periſh for want of nouriſhment? How is it poſſible for them to forget to ſuch a degree the care of their own life? This muſt be the caſe if they conſtruct no combs: their reaſons for this proceeding are pretty apparent: but they might at leaſt collect from the flowers as much honey and wax as are neceſſary for their preſent ſubſiſtence.

Here the ultimate cauſe is pretty evident: the preſervation of the ſpecies is of more importance to nature than that of individuals: in the preſent caſe, where the former could not take place, the latter would become uſeleſs. With regard to the efficient cauſe, it is not eaſy to penetrate into it. Can the neuters be abſolutely diveſted of the ſenſe of hunger? Are they only induced to collect wax and

honey, and to feed upon it, merely from the agreeable impreſſion the ſight of the matters on the flowers produces on the organ? This would be very ſingular; for hunger is a ſenſation common to all animals, or ſeems to be ſo. It is a means wiſely eſtabliſhed, to prevent the deſtruction of individuals, by exciting them to repair the continual loſſes which the different evacuations occaſion. But in the choice of the method in queſtion, nature could not propoſe to herſelf as a principal object the preſervation of individuals, as individuals, but rather as the authors of generation, or the preſervers of the ſpecies. In fact; amongſt quadrupeds, birds, fiſhes, reptiles, and almoſt all inſects, each individual is either male or female, or both together, as earthworms, ſnails, &c. In them we ſee that the preſervation of the ſpecies immediately depends on that of individuals. The caſe is not the ſame with reſpect to the bees: the greateſt number of thoſe that compoſe the ſame ſociety is deprived of the diſtinction of ſex, and only contribute to the preſervation of the ſpecies in quality of a ſecondary cauſe. It will not therefore ſeem improbable that the neuters are deprived of the ſenſe of hunger. We ſee plainly that the queen and the males cannot be deprived of it; foraſmuch as they eat frequently.

But if the neuters are not capable of feeling hunger, how are they prompted to repair their ſtrength which is exhauſted by labour and perſpiration? The neuters, which have a queen at their head, are excited to labour by her preſence. They cannot attend upon the various labours they are charged with, without finding frequent opportunities to take nouriſhment. The reaſon is, that independently of the agreeable ſenſation which may reſult from the action of the wax and honey on the organ

organ of the neuters, theſe matters muſt neceſſarily paſs through their ſtomach, and be there digeſted and prepared, before they are depoſited in the hive, to anſwer the uſes for which they are deſigned.

It will perhaps be objected that it is ſtrange, that amongſt individuals of the ſame ſpecies, there ſhould be ſome of them endued with a ſenſation altogether unknown to others. But is it not equally ſtrange, that amongſt theſe ſame individuals, ſome are provided with organs which are not to be found in the reſt? The labouring bees have ſome, which are not to be ſeen either in the queen or the males; and theſe, on the other hand, have likewiſe ſuch as are not perceived in the working bees. The deſtination not being alike for all the individuals, the means correſponding thereto muſt neceſſarily differ.

Another reflection offers itſelf in ſupport of the conjecture I have ventured to advance: hunger is a preſſing, active, and reſtleſs ſenſation; now the neuters, when deprived of their queen, fall into a kind of drowſineſs, which continues as long as they live. If during this ſtate of lethargy we give them a queen, they immediately awake, and betake themſelves to work.

With a view to diſcover the fundamental law of the government of our republican bees, a hive has been divided into two nearly equal parts; and it has been always obſerved, that ſuch bees as had no queen, made no combs. This alone was a very deciſive experiment: but there remained another ſtill to be tried; and that was, to divide a hive that was well ſtocked with combs, inhabitants, and young, and to trace attentively all that paſſed in that part of the hive where the queen was not. One would naturally conjecture, that the neuters would continue their diligence in the education of the young,

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and that they would not ceaſe working till the latter were become bees.

By a very ſimple method, two hives are obliged to make a reciprocal exchange of their hives and combs: they are reconciled to this change, and the neuters of each hive take the ſame care of the young they find in their new habitation, as if they were their own proper nurſlings. The affection of the neuters then extends itſelf indifferently to all the nymphs. Therefore this inſtinct has a direct relation to the preſervation of the ſpecies. It is neceſſary to vary in ſome meaſure this experiment, in order to ſound the diſcernment of the neuters, and to ſubſtitute with ſkill the nurſlings of a different ſpecies inſtead of thoſe of their own.

The neuters are of neither ſex; they do not procreate, how then can we ſuppoſe that there is preciſely the ſame affection in them towards the young of their queen, as reſides in the mothers of other animals? Notwithſtanding which, they act like them in the ſame circumſtances. If then nature has been enabled to intereſt the attachment of the mothers, by the agreeable ſenſations their young occaſion them to experience, or by the ſervices they derive from them, it is highly probable that her proceeding is nearly the ſame with reſpect to the labouring bees, and that ſhe has implanted in the young, towards them, a ſecret cauſe of agreeable ſenſations, whereby they are attached to them, and induced to diſgorge into their cradles that kind of nutriment which contributes to their nouriſhment.

We have ſeen, that if ſeveral queens be introduced into a hive, there will never be more than one to hold the reins of government: all the reſt will be put to death. We are not yet thoroughly informed, whether the dominion always veſts in the lawful queen, or how and by whom the ſupernumerary

numerary queens are ſacrificed. It is not probable that the neuters are charged with theſe cruel executions: they pay the ſame homage to ſtrange queens as to their lawful ſovereign. But the queens are armed with a ſtrong and ſharp ſting, and we cannot ſufficiently account for the utility of this offenſive weapon, if they do not employ it either for defending or acquiring a throne. Be this as it may, we can clearly comprehend why it was ordained, that there ſhould never be more than a ſingle queen in each hive. A ſwarm, how numerous ſoever it may be, is hardly ever too much ſo for one mother only; which in the courſe of a year can eaſily lay fifty thouſand eggs. A proportionable number of cells is requiſite for theſe eggs; and all of them are not employed for lodging the young. Thus it happens, that when the hive is ſomewhat defective, the mother is obliged to depoſit three, four, or five eggs in the ſame cell, and as there is not ſufficient room in each for any more than one at a time, the ſupernumeraries are always ſacrificed, which is a loſs to the republic.

It is unqueſtionably the office of the neuters to exterminate the males, when they are become uſeleſs to the community. But do the neuters know that they would periſh with hunger were they to preſerve them? It is highly probable their ſagacity does not extend ſo far. Suffice it to admit, that there is a certain time when the males make ſuch an impreſſion on the ſenſes of the neuters as tends to irritate them, and prompts them to deſtroy them.

Whilſt the ſeaſon continues favourable for collecting honey and wax, the neuters never ceaſe to gather it, and fill the magazines. Not that they can foreſee long before-hand that a ſeaſon is nigh when theſe harveſts will be denied them. It would be very unphiloſophical to attribute ſuch foreknowledge

ledge to bees. Can beings that neither have, or can have pure ſenſations, pry into futurity. All has been ſo well ordained, that the bees are furniſhed with proviſions, without thinking or being capable of thinking of any precautions neceſſary for that purpoſe. They have been inſtructed to gather honey and wax; they apply themſelves to it during the ſummer ſeaſon, and on the return of winter, the combs are always filled with wax and honey.

Are thoſe combs, in which ſuch profound ſkill in geometry is diſplayed, indeed the work of geometrical inſects? The more geometrical the work appears to any one, the leſs geometry he ſuppoſes in the workman. It is ſelf-evident, that here the geometrician is the AUTHOR of the inſect. The latter executes a work by a kind of mechaniſm, whoſe proportions a Koenig and Cramer calculate with aſtoniſhment, but cannot account for them. That underſtanding which is able to form a perfect idea of the body of a bee, will doubtleſs perceive in it that little machine, which conſtructs theſe cells ſo œconomically regular. It would judge of the effects reſulting from this machine, as a mathematician judges of thoſe of an engine, or any other machine. Let us judge from this piece of ſkill, which is of itſelf ſo deciſive, of the other operations of the bees. Can we think that they are leſs mechanical? We will not advance that bees and all other animals are mere machines, clock-work, engines, &c. There is perhaps a ſoul connected with the machine; it is ſenſible of its motions, is pleaſed with them, and receives from the machine agreeable or unpleaſant impreſſions, and this *ſenſibility* is the ground and ſole mobile of the animal. This example alone will be ſufficient, one would think, to convince every judicious reader, how greatly we are miſtaken in beſtowing ſo liberally on animals

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our method of thinking and reaſoning, and almoſt our diſpoſition itſelf. To be ſatisfied of this, we need only apply to the conſtruction of the honey-combs thoſe ideas of reaſoning which we adopt with ſo little reflection in favour of bees, and we ſhall transform them at once into ſublime geometricians. They would then likewiſe be acquainted with botany; for they know perfectly well, perhaps better than we do, thoſe parts of plants in which the ſap is contained.

Notwithſtanding all the attention which the greateſt obſervers have beſtowed on bees, there ſtill remain many more intereſting things to be ſhewn to us than they have hitherto diſcovered. It will be particularly needful for them to contrive a method for procuring a clear inſpection of them, whilſt they are buſy in forming thoſe minute lozenges which are the baſe of the cells, and the moſt curious part of the work. By dint of obſervation they will at length diſcover ſuch particularities as will unravel the myſtery of the mechaniſm I ſpoke of. The bees always flock together in ſuch numbers when they begin to conſtruct a comb, that it is hardly poſſible to diſcern their manner of working. An eſſential point would be, to cauſe but a ſmall number of labourers to work at a time. The obſerver knows how to turn himſelf about, to invent, and to draw new inſtructions and views even from obſtacles themſelves. The ſtudy of natural hiſtory ſeems to be the beſt adapted for perfecting the ſagacity of the human mind.

We will remark as we conclude, the ſingularity of the means the AUTHOR of nature has choſen for preſerving the ſpecies of bees. We are preſented with three kinds of individuals, that may be called three diſtinct ſpecies. The mothers, which are almoſt every-where beſides ſo taken up with the

the care of their young, we find here only give them birth. Other mothers, nurſing mothers bring them up, and have the ſame regard for them as though they had given them being. They not only tend, nurſe, and protect them, but likewiſe frame the neſts and cradles appointed for them to grow in; and the conſtruction of theſe neſts is executed with ſo much art, and the ground-work and matter of them ſo ſkilfully contrived, that it cannot be juſtly eſtimated but by ſtiling it an excellent piece of geometry.

CHAP. XXVI.

Beavers.

OF all animals that live in ſociety, none approach nearer to human underſtanding than beavers. We are ſtruck with aſtoniſhment, almoſt to a degree of ſtupefaction, at the ſight of their work, and, on reading their hiſtory, are apt to imagine it to be that of a ſpecies of men. We are at a loſs to determine what is moſt worthy of admiration in their labours, whether the grandeur and ſolidity of the undertaking, or the prodigious art, fine views, and general deſign ſo excellently diſplayed throughout every part of their execution. A ſociety of beavers ſeem to be an academy of engineers, that proceed on rational plans, which they rectify or modify as they judge neceſſary, purſuing them with as much conſtancy as preciſion; are all animated by the ſame ſpirit, and unite their will and ſtrength for the promoting one common end, which is always the general good of the ſociety. In a word, we muſt be witneſſes of their performances, before we can judge them capable of them. A traveller that is ignorant of them, and happens to meet with their

their habitations, will think he is among a nation of very induſtrious ſavages.

About the month of June or July the beavers form themſelves into a body, to the number of two or three hundred. They aſſemble themſelves on the banks of lakes or rivers. It is well known that they are amphibious. It is of particular importance for them to poſſeſs themſelves of the waters in the midſt of which they build, and to prevent the bad effects reſulting from their increaſe or abatement. This they effect, as we do, by banks and ſluices. The ſurface of the waters of a lake vary but little and ſlowly. If then they take up their reſidence on a lake, they diſpenſe with the charge of a bank; but never fail to raiſe one when they eſtabliſh themſelves on a river.

This mole or bank is oftentimes a work of immenſe labour, and it is inconceivable how brutes are able to project, begin, and complete it. Repreſent to yourſelf a river of fourſcore or an hundred feet in width. Their firſt buſineſs is, to break the force of the current. The beavers then throw up a bank or cauſeway eighty or an hundred feet in length, by ten or twelve feet at its baſe. Nothing is more certain than this, nor leſs likely; and when we have repeatedly ſeen it, are ſtill willing to renew our inſpection of it, in order to enforce our belief.

Beavers are provided with no other inſtruments than four ſtrong inciſory teeth, four feet, the two anterior of which are furniſhed with a kind of toes, and a ſcaly tail, ſhaped like an oval ſhovel. Nevertheleſs they are able to ſubdue the waters by ſuch inſtruments as theſe, and challenge our maſons and carpenters to equal them when armed with their trowel, plummet, and ax.

If they find a great tree on the border of the river, they cut it down at the foot; ſtrip off the branches,

branches, that they may lay it lengthwiſe, and make it ſerve as the principal part of the bank. Whilſt one part of the beavers are employed about this work, others go in ſearch of little trees, which they cut and lop like ſtakes, and convey both by land and water to the place appointed for uſing them. With theſe ſtakes they conſtruct piles, which they ſtrengthen by intermingling branches of trees betwixt them. At the ſame time other beavers bring thither a kind of morter, which they have kneaded with their feet. This they diſtribute in the vacant places between the piles, and afterwards beat it with their tail. In this manner they plant ſeveral rows of piles, the inner part of which is ſolidly compacted. On the top of the bank they leave two or three openings to admit the diſcharge of the water, which they can widen or contract as the river riſes or falls. If by the violence of the current, a breach is made in the bank, they apply themſelves immediately to the repairing of it.

The bank is properly ſpeaking a work of a public nature, on which all the beavers labour in concert. As ſoon as it is finiſhed, the grand ſociety divides itſelf into ſeveral particular ones, each of which chooſes their quarter, where they build for themſelves a commodious habitation. This is a kind of hut or cottage, either round or oval, with one or more ſtages, all built on piles, which latter ſerves at the ſame time for the foundation and floor. The walls are about two feet thick, and very ſtrongly built. The partitions are lined with a kind of ſtucco, which is ſo properly applied, that it ſeems to have been executed by mens hands, and is nevertheleſs intirely performed by the tail of the beaver. The floor is covered with a green carpet, which they never ſuffer to be ſoiled. The cottage has always two outlets, one by land, and the other by water.

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The largeſt cottages are eight or ten feet diameter, the ſmalleſt four or five. The former are ſufficient to lodge ſixteen, eighteen, or twenty beavers, the latter ſix or eight. There are always as many males as females.

Their common food is the bark of ſome tender tree, as the alder, poplar, or willow. Againſt the winter, they amaſs a ſufficient quantity of it in magazines under water. Each cottage has its magazine, from which all the members of the little ſociety may be ſupplied.

The moſt conſiderable towns of the beavers conſiſt of twenty or twenty-five lodgments; though ſuch are but rare. The moſt common have only ten or twelve. Each republic has its peculiar diſtrict, and admits of no accidental gueſts.

With reſpect to them, the union of the male and female ſeems to be not ſo much the effect of neceſſity as choice. After having laboured in concert with the other beavers on the public and private works, the happy couple taſte the pleaſures of domeſtic life, and ſuch as are attached to conjugal ſociety.

The female commonly brings forth two or three young ones at a time; and ſhe has the ſole care of their education. The male never takes any part in it. He is abſent from the houſe at that time; returns to it however now and then, but never takes up his abode there.

When any great inundations damage the edifices of the beavers, all the ſocieties without exception unite together for making the neceſſary repairs. If hunters declare a cruel war againſt them, and intirely deſtroy their banks and cottages, they diſperſe themſelves about the country, betake themſelves to a ſolitary life, dig burrows or trenches under-ground, and never ſhew any marks of that induſtry we have been admiring.

CHAP.

CHAP. XXVII.

Reflections on the beavers.

BEAVERS ſeem to be formed with a view to confound our reaſonings. Their aſſociating themſelves into great bodies, for working in concert on their immenſe works; their ſeparating into little families or particular ſocieties charged with the conſtruction of the huts; the nature of theſe works, their extent, ſolidity, propriety, and appropriation ſo conducive to one general end, comprehending ſuch a number of ſubordinations; in a word, their almoſt perfect reſemblance with works erected by men with the ſame intent; all concur to give the labour of the beavers an undoubted ſuperiority over that of the bees, and ſeem to indicate that to be much leſs mechanical. In fact, to fell trees choſen on purpoſe, to lop them, and cut off their projections, to make great croſs-pieces of timber of them, diſpoſing them in their proper places; to cut ſmaller trees like ſtakes, plant ſeveral rows of theſe ſtakes in a river, and interlace them with branches of trees, in order to ſtrengthen and connect them together; to make morter, and with it ſolidly to compact the inſide of the pile; and to all this to add the form, proportions, and ſolidity of a great bank; to form ſluices thereon, and open or ſhut them according to the water's elevation or abatement; to build behind the bank little houſes one or more ſtories high, founded on an entire pile-work; to build them ſolidly without, and incruſtate or cement them within by a layer of plaiſter applied with equal exactneſs and propriety; to cover the flooring with a verdant tapeſtry; to contrive lights and outlets in the walls for different purpoſes; to

erect magazines and ſupply them with proviſions; to repair with diligence and induſtry whatever breaches may happen to the public works, and to re-unite themſelves into one grand body for the effecting in common theſe reparations; are aſtoniſhing marks of induſtry, which ſeem to imply in the beavers a ray of that light, which raiſes man ſo far above the reſt of the animal creation.

Let us however miſtruſt theſe firſt motions of admiration. Our wonder ſeizes an object too forcibly, and does not ſuffer it to be eſtimated by reaſon. Surely the conſtruction of a great bank, or of a houſe, are not to be compared with that of a cake or comb of wax, and hexagonal cells with pyramidal bottoms! We are ſenſible that the comb and cells may be in ſome ſort caſt in a mould; but there cannot be a mould for a ditch or a houſe. You are not to take a figurative expreſſion in a literal ſenſe. The workmanſhip of the bees is not caſt in that manner, as a natural philoſopher has endeavoured to perſuade us on deceitful compariſons. It is formed, to uſe the expreſſion, by hand; but this hand may operate mechanically. We cannot compare the gathering, preparation, and uſe of the duſt of the ſtamina, to the collating, preparing, and uſe of the materials of a bank. The labours of the beavers are certainly of a different nature from thoſe of the bees; they affect, as do ours, a multitude of relations, which would induce us to judge them to be *reflected*, were we to yield to the firſt impreſſions, and not to analyſe the ideas repreſented to us by the word *reflection*. Certain we are that the beavers are not better engineers or architects than the bees are geometricians. Do we not ſee that, if the beavers were poſſeſſed of our notions of genius and architecture, they would not now build exactly like thoſe in Veſpuce's time? The human mind combines

combines and perfects without ceasing; that of the beavers neither perfects or combines. Were they only for once to erect square cottages! but they are eternally either round or oval. They move, like the planets, in the circle which nature has traced out for them, and never deviate from it. It were in vain to object that the savages now a days build like those of former times: if savages do not perfect, they have nevertheless a faculty for so doing. Their brain is organised like ours; they have the gift of speech; they exercise amongst themselves a certain right of nations, greatly superior to all the policy of the beavers. And if any Vaubans or Perraults should ever spring up in the midst of these rude people, their little towns would become cities, and their cottages palaces. Do you expect to find Vaubans and Perraults amongst the beavers? The materials whereof nature has formed these animals are not of the same texture as those wherewith architects are composed. But she appears sometimes to make architects and geometricians, when she produces only more labourers and automatons. Every animal has received its particular gifts and measure of industry relative to its destination. In some, mechanism is so palpable, that we cannot help perceiving it. In others, it is so disguised under the appearance of reflection and parts, that it seduces us so much the more effectually as we are fond of being so. Besides, it is much easier for us to cause the brute to reason like a man, than the man like a brute.

We will grant this: the beavers will always be an impenetrable enigma to the philosophers. They are endued with a kind of understanding, which seems to place them betwixt man and other animals. Let me however be allowed to hazard a conjecture, which I shall only offer as such. Is not

the doctrine of *innate ideas*, which formerly had ſo many partiſans, and has ſince been ſo ſolidly refuted, applicable to brutes? The brute is at its birth what it will remain during its whole life. Its feebleſt eſſays are always maſterly ones. No demurrings, no miſtakes properly ſo called. The young bees work as regularly as the moſt experienced. Birds that have never ſeen a neſt, build one in the ſame manner as their predeceſſors. Beavers have no academy for their youth to ſtudy in. Do not therefore bees, birds, and beavers bring with them into the world the ideas of honeycombs, a neſt, bank, and cottage? May not their body have been conſtructed and raiſed on determinate relations to theſe ideas? May it not repreſent, by theſe various motions, the ſpecies, reſult, and order of theſe ideas? But it is univerſally agreed that the ideas derive their origin from the *ſenſes*, which can ſuſtain no difficulty with reſpect to animals, ſince all their ideas are purely ſenſible. They all conſequently depend on the ſenſes; and it is even probable, that every idea has certain fibres in the brain appropriated to it. This we have elſewhere ſhewn †. So that we are not to ſuppoſe that the ſoul of the animal, when firſt produced, actually contains in it all the ideas relative to its preſervation, and that of its ſpecies; but that the brain does actually contain fibres proper for exciting thoſe ideas in the ſoul, and that too in a certain order, and relatively to ſuch or ſuch a circumſtance, in which the animal ſhall one time or other be. They are not therefore properly *innate ideas* which we would admit; they are *innate fibres*. According to this hypotheſis, the brain of beavers might originally contain an aſſemblage of fibres

† Part v. ch. 3. 6.

proper for repreſenting to the ſoul a bank, a cottage, pile-work, &c. and the execution of the whole. There would likewiſe be in the animal two particular ſyſtems, correſponding with each other; one a *repreſentative* ſyſtem, having its ſeat in the brain; the other an *executive* ſyſtem, reſiding in the members and other organs, deſtined to execute the repreſentations, or to realize them. And as theſe two ſyſtems have been calculated on relations determined by the different circumſtances in which the animal may happen to be, it is very natural that their exerciſe ſhould vary according to the diverſity of the ſituations of the animal, and his actual neceſſities. The reader muſt comprehend my meaning. He will be apt to entertain a more favourable opinion of me than to imagine, that I preſume I have met with a word that is truly expreſſive of the enigma. I have only ſubſtituted inſtead of it a term that repreſents it.

As to the beavers not diſplaying their induſtry and talents except in a ſtate of ſociety, their ceaſing from labour when obliged to live ſolitarily or as priſoners, and appearing at that time almoſt ſtupid; this is not more ſurpriſing than the languid and totally inactive ſtate the bees fall into when deprived of their queen. Five or ſix bees, if ſeparated from their hives, will not conſtruct the leaſt cavity of a honey-comb, nor even a ſingle outline of it. This kind of ſolitude does not however deprive them either of their talents or organs. But the republican bees were ordained to live in ſociety; were organized for that ſtate: ſolitude renders their organs inactive, they are therein deſtitute of motion. Other bees, which are appointed to live ſolitarily †, have been organized in a relation to this different

† See chap. 5. of this part.

diſtinction:

diſtinction: each individual amongſt them performs by its own ſtrength thoſe admirable works which among the others are performed by the united abilities of a great number of individuals. Beavers were not organized principally for ſolitude, but for ſociety. That it is that which muſt ſet a true value on their talents, and put their organs in exerciſe. Solitude leaves the greater part of theſe ſprings without action and without life.

Beavers ſtill call for a greater degree of ſtudy to be beſtowed on them, and that by ſuch obſervers as are not to be miſled by the marvellous. It would be neceſſary to attempt to bewilder them by laying different obſtacles in their way, modifying more or leſs the form of their work, and by artfully ſubſtituting ſtrange materials inſtead of their own, &c. A competent number of theſe experiments would throw a light into thoſe bye corners where we now behold nothing but darkneſs and obſcurity.

PART X.

Continuation of the induſtry of animals.

CHAP. I.

A ſummary account of the induſtrious proceedings of divers inſects relative to their metamorphoſes.

WE ſhall in the next place treat of the proceedings of *ſolitary* animals. If they do not affect that extraordinary air of reflection and prudence, that brightneſs of genius, and that ap-

pearance of policy and legiſlation which we admire in *ſociable* animals, they nevertheleſs attract our regard, either by their ſimplicity and ſingularity, or their diverſity and appropriation to one common end, for the attaining of which they are the ingenious and natural means. After having contemplated the government, manners, and labours of a *republican* community, we may ſtill find ſome pleaſure in conſidering the life and occupations of a *ſolitary* one, thus paſſing from the monuments of *Rome* to the cottage of a *Robinſon*. Thoſe works that are performed by the ſociable animals, and which aſtoniſh us as much by their ſize, as by the beauty of their diſpoſition, reſult from the concurrence of a number of individuals. They all paſs through various hands: ſome ſketch them, others bring them to a greater perfection, and a third ſort finiſh them. The works of ſolitary animals ſpring from one head only; the ſame hand that begins them, continues, finiſhes, and repairs them. Each individual has his particular talent, and degree of ſkill, whereby he provides for his own ſubſiſtence, and furniſhes himſelf with all neceſſaries.

We will here confine ourſelves to the proceedings relative to the *metamorphoſis*: this is an affair of great importance for one of our hermits to prepare himſelf for. His preſervation depends on the precautions he has recourſe to on the approach of this epoch, which is the moſt intereſting to him of any during his whole life. *Caterpillars* alone exhibit to us examples of almoſt all the proceedings which nature has taught to inſects of this kind. We will limit our examinations to this claſs in particular.

CHAP.

CHAP. II.

Caterpillars that hang by their hind-part.

YOU have ſeen † that the *chryſalis* cannot act; and why? becauſe the *caterpillar* performs all, and ought ſo to do. The moſt eſſential point of all is, to put the chryſalis in a condition to extract itſelf without endangering the veſture of the caterpillar. They have divers methods for effecting this. The moſt ſimple is, by ſuſpending themſelves by their hind-part. They ſpin a ſmall maſs of ſilk on a certain prop, they faſten their two hind legs ſtrongly to it, and in this manner hang with their heads downward. In this ſingular attitude they go through their metamorphoſis uncovered. The veſture of the caterpillar opens itſelf, and cauſes the chryſalis to appear. It diſengages itſelf every moment more and more. But what muſt become of it when it has entirely quitted the veſture? How will it ſupport itſelf in the air? How can it fix itſelf to the place where the caterpillar was before? It has a little tail, and this tail is provided with hooks. Its whole body is at this time very ſupple. With her rings, that are like hands, ſhe ſeizes a part of the veſture, and faſtens herſelf to it. In an inſtant afterwards ſhe lengthens her hinder part, and, with other rings, catches hold of a more elevated part of the veſture. By this method ſhe creeps backwards on her ſpoils as on ſtairs, and at laſt is enabled to fix her tail on the maſs of ſilk. The contiguous part of the ſpoils incommodes her; ſhe agitates her body by turning it round, in order to make them fall off, which ſhe generally accompliſhes. Probably this

† Part IX. chap. 10, &c.

whirling about has not ſo rational an end, as a great admirer of inſects ſeems to believe: the friction of the ſpoils irritates more or leſs the very delicate ſkin of the chryſalis, and puts it in motion. Being ſuſpended by a thread, it is very natural for it to turn round, and that the ſpoils ſhould yield to theſe ſmall reiterated impulſions. There is an infinite number of facts of the like kind, which are too much exalted, and wherein we are not to ſeek for the marvellous, any more than in this.

CHAP. III.

Caterpillars that faſten themſelves with a girdle.

IT did not ſuit with other caterpillars to be ſuſpended after the manner of theſe. Their bodies are in ſome meaſure ſupported by a prop, and nature has taught them the method of effecting this. They wind a girdle round their body, compoſed of a number of ſilk threads collected together, whoſe ends are fixed to the prop that ſuſtains them. By this means they faſten their hind legs in a little heap of ſilk. It is eaſy to imagine after this, that the chyſalis muſt be tied and grappled as the caterpillar was. The girdle is looſe, and leaves the chryſalis ſufficient room to perform its little operations.

CHAP. IV.

Caterpillars that form cones.

MANY other ſpecies have recourſe to very different methods in order to prepare themſelves for their metamorphoſis. They incloſe themſelves in cones, where they go through their transformations

tions under cover. Who is there that the ſilk-worm has not made acquainted with this her induſtry? But we are miſtaken, if we imagine that all ſuch caterpillars as conſtruct cones, work on the model of the ſilk-worm. Their manufactures are as various as thoſe which ſupply us with our clothes and furniture. We regret that our limits will not allow us to ſtop a while at theſe little work-houſes, in order to conſider more narrowly the various and ingenious proceeding of the labourers, and the form and effects of the inſtruments they ſo ſkilfully make uſe of: but we will take a ſlight view of their work, and the diverſity of their performances.

The cones moſt generally known are of pure ſilk. Such is that of the worm which provides ſo largely towards the gratifying our luxury. They are commonly of an oval form. This they owe to the body of the inſect, on which they are moulded. In working, they turn themſelves round in form of an S or ſemicircle; and it is very evident, that the threads with which they then cover themſelves, muſt deſcribe an oval round them, either longer or ſhorter. The cone is a kind of bottom, produced by the circumvolutions of the ſame thread. Herein I make uſe of a rude compariſon, and which is far from being an exact one: there is more art in the conſtruction of a cone than in the formation of a bottom; but this art is in part a myſtery. The thread does not properly revolve round the cone; it delineates in it an infinite number of zig-zags, that compoſe different layers of ſilk, from whence reſults the thickneſs of the maſs. A ſpinning inſtrument, placed near the mouth of the inſect, moulds this precious ſilk. Before it paſſes through this inſtrument, the matter from which the ſilk is produced appears like a gum, almoſt liquid, contained in two great reſervoirs, that wind

like the inteſtines, and terminate at the ſpinning inſtrument by two ſlender parallel canals. Each canal likewiſe furniſhes matter for one thread: the inſtrument above-mentioned unites theſe two threads in one, and the microſcope demonſtrates this union. A ſilk thread, therefore, which appears to be ſingle is in fact double. A ſpider's ſilk thread is compoſed in a very different manner, though prodigiouſly fine: it is formed by the union of ſeveral thouſands of threads, that paſs through different ſpinning inſtruments. The immortal hiſtorian of the ſilk-worm is aſſured that the cone of that inſect is formed of the net-work of one and the ſame thread, whoſe length is upwards of nine hundred Boulogne feet. Writers that are apt to be too fond of the marvellous, have extolled beyond meaſure the fore-ſight of the ſilk-worm: they have repreſented it to us as capable of foreſeeing its approaching diſſolution, and of ordering itſelf the neceſſary preparations for its funeral. Theſe pretty conceits require a greater degree of exactneſs. The ſilk-worm, it is true, acts as though it were endued with foreſight; but does it therefore follow that it can foreſee, and might it not act preciſely in the ſame manner without being capable of ſo doing? When it has attained to its full growth, its reſervoirs of ſilk are as full of ſilk as they can be: it is apparently preſſed by neceſſity to evacuate this matter; it accordingly does evacuate it, and the cone is the natural conſequence of this neceſſity, and of the attitudes the animal aſſumes in ſatisfying it. Theſe attitudes are doubtleſs ſuch as are the moſt ſuitable. He relieves himſelf likewiſe by varying them, and, being nearly cylindrical, in what manner ſoever he turns himſelf, always tends to deſcribe an oval. By traverſing his ſpinning inſtrument on all ſides, he thickens more and more the

weft

weft of his cone. Such in general is the manufacture of all cones of this kind. The weft of ſome of them is ſo fine, compact, and ſmooth, that it ſeems perfectly membranous.

Some of our ſpinners give their cone a more exquiſite form, ſo as to reſemble that of an inverted boat. The cone of a ſilk-worm is made, if we may be allowed the expreſſion, of a ſingle piece. The cones made boat-wiſe conſiſt of two principal parts, ſhaped like ſhells, and joined together with great ſkill and propriety. Each ſhell is worked ſeparately, and formed of an almoſt infinite number of very minute ſilk rings. On the fore-part of the cone, which repreſents the hind-part of the boat, is a ledge that juts out a little, in which we may perceive a very narrow crevice, which denotes the aperture contrived for the exit of the butterfly. By means of that, the two ſhells may part aſunder, and leave room for the butterfly to paſs through them. They are conſtructed and put togther with ſo much art, that they are of the nature of a ſpring, and the cone from whence the butterfly has lately iſſued appears as cloſe as that which it ſtill inhabits. By this ingenious artifice the butterfly is always free, and the chryſalis in ſafety. We ſhall hereafter come to treat of proceedings which are analogous to theſe, but more ſingular.

Our ſpinners have not all an equal proviſion, yet all ſeem to endeavour at concealing themſelves from ſight. Such as are not rich enough to make themſelves a good lodgement of ſilk, ſupply the want of it by different matters of a coarſer or finer texture, which they are ſufficiently ſkilful to cauſe to contribute towards the conſtruction of the lodge. Some content themſelves with giving it a covering of leaves, which they connect together without any art. Others do not confine themſelves to the

[a]maſſing theſe leaves, and diſpoſing them indiſcriminately; but range them with a kind of regularity. Others think proper to powder the whole of their cone with a matter they yield from behind them, and which they cauſe to penetrate betwixt the thread. Others ſtrip themſelves of their hairs, and form a maſs of a mixture of ſilk and hairs. Others, after having ſtripped themſelves, plant their long hairs about them, and make of them a ſort of cradle fence. Others add a greaſy matter, which they procure from their inſide, to the ſilk and hairs, with this they ſtop up the rings of the weft, and it ſerves as a varniſh for them. Others thruſt themſelves into ſand or ſmall gravel, and there conſtruct for themſelves cones of ſand, whoſe grains are connected with the ſilk. Others, laſtly, which have ſilk, pierce the earth, make a cavity in it like a cone, and ſmear the ſides of it with a kind of glue or paſte.

Another ſpecies, which is far more induſtrious than the former, perform a work which we cannot too much admire. You have lately ſeen deſcribed thoſe cones which reſemble an inverted boat: this is likewiſe the form that this ſpecies give to their cone; but they do not make it intirely of ſilk. They ſtrip off little pieces of bark with their teeth, of a rectangular figure, nearly even and alike, and diſpoſe them with all the ſkill and propriety of an eboniſt; with theſe they compoſe the principal parts of the cone. Theſe great parts are likewiſe formed of a conſiderable quantity of very ſmall inlaid work, placed end to end, and joined together with ſilk. In a word, we are apt to fancy that we are looking at an inlaid floor, or a piece of inlaid work.

Another caterpillar likewiſe works in wood, but not with the ſame art. Its cone, which is of the ordinary

ordinary form, is only made of little irregular fragments taken from dry wood. The ſecret of the inſect conſiſts in uniting theſe fragments, and compoſing a kind of box of them. This they effect by holding them for a few moments in their mouth, moiſtening them there, and paſting them together by means of a ſort of glue, which ſerves them inſtead of ſilk. Of this mixture a cone is formed, whoſe ſolidity nearly equals that of wood. The butterfly has no inſtrument to pierce it with; it may probably be able to ſoften it. It is the caterpillar that poſſeſſes the acid liquor I ſpoke of †. This liquor ſenſibly ſoftens the cone; and it has been conjectured with ſome foundation, that it was prepared long before in order to put the butterfly in a condition to make its exit.

CHAP. V.

Falſe caterpillars, that conſtruct double cones.

SOME inſects, whoſe reſemblance to caterpillars has occaſioned them to be called *falſe caterpillars*, can alſo form cones for themſelves, which preſent us with ſome new ſingularities. They are really double; I mean, that two cones are incloſed within each other, without being joined together. The outer cone ſeems to be made of parchment that ſometimes conſiſts of net work. The inner cone, on the contrary, is of a very fine contexture, extremely ſilky and gloſſy.

† Part VIII. chap. v.

CHAP. VI.

Inſects that live in fruits.

THE moſt ſolitary of all inſects are ſuch as live in the inſide of fruits. It has been proved, that each fruit lodged only one caterpillar or worm. We are ignorant of the cauſe of this remarkable fact. We only know, that a curious obſerver having attempted to cauſe caterpillars of this ſpecies to live together, they furiouſly engaged each other as often as they met. It is then inconteſtably true, that the diſpoſition of theſe caterpillars is anti-ſociable. Several have metamorphoſed themſelves in the very fruit that has ſerved them for a retreat and for proviſion; they dig cavities in it, which they line with ſilk, or in which they ſpin their cones. Others, which are the greater part of them, quit the fruit, and metamorphoſe themſelves in the earth.

CHAP. VII.

Inſects that fold and roll up the leaves.

THOSE inſects that roll up or fold the leaves of a great number of plants are alſo perfect hermits. This proceeding is common to many caterpillars. They thus procure for themſelves little cells, which are convenient lodgings for them, in which they are always ſure to find nouriſhment, for they eat the walls of the cell; but they are always very careful never to touch that part which is deſtined to cover them. The different methods in which theſe caterpillars lodge themſelves, give room

room for diſtinguiſhing them into *tyers*, *folders*, and *rollers*.

The art of the *tyers* is in general the moſt ſimple. It conſiſts in joining ſeveral leaves together with ſilk threads, in order to form them into one intire parcel, in the center of which is the lodge of the little hermit.

The procedure of the *folders* ſuppoſes more refined operations. They fold the leaves either *in the whole*, or *in part*. In the *whole*, when the portion folded is turned back flat upon another part of the leaf: and in *part*, when they only ſimply bend the leaf more or leſs.

But the labour of the *rollers* is moſt of all to be admired. They live in a kind of roll, whoſe dimenſions, form, and poſition vary in different ſpecies. Some give it a cylindrical figure; others, the form of a cone, which is likewiſe as well-made as thoſe the grocers uſe. The leaf is always rolled ſpirally, or as *wafers* are. The roll or cone is commonly laid on the leaf; but ſometimes, which is very remarkable, it is fixed on it like a nine-pin.

Does my reader imagine that mechaniſm preſides over the conſtruction of theſe various works? Does he conceive in what manner an inſect, that has no claws, is able to roll up a leaf, and to keep it ſo? We know in general that caterpillars ſpin: and can in ſome meaſure diſcover, that it is by the aſſiſtance of their threads that our ſkilful rollers cauſe the leaves to take the form of a cylindrical or conical tube. We ſee in effect parcels of threads diſtributed from one diſtance to another, which hold the roller confined to the leaf. But how can theſe threads, which ſeem only to perform the office of ſmall cables, be capable of rolling up the leaf? This we imagine ourſelves able to gueſs at, but without

effect.

effect. We ſuppoſe, that by faſtening threads to the edge of the leaf, and drawing theſe threads towards her, the caterpillar forces the edge to riſe and turn itſelf; which is by no means the caſe. The uſe the induſtrious inſect makes of its ſtrength, conſiſts of a more refined mechaniſm. He fixes a number of threads to the border of the leaf, but does not draw it to him. By means of them he builds the other extremity to the ſurface of the leaf. The threads of one and the ſame parcel are nearly parallel, and compoſe a little ribband. By the ſide of this ribband the inſect ſpins a ſecond, which paſſes over and croſſes the former. This then is the ſecret of its mechaniſm. In paſſing over the firſt ribband in order to extend the ſecond, it bears on the firſt with the whole weight of its body; this preſſure, which tends to force down the ribband, obliges the edge of the leaf to which it is faſtened, to riſe. The ſecond ribband, which is at the ſame time ſtruck on the flat part of the leaf, preſerves on the edge that alteration or bending which the inſect was diſpoſed to give it. If we narrowly examine theſe two ribbands, their effect will be viſible. The ſecond will appear very tight, and the firſt very ſlack; the reaſon is becauſe the latter has no greater degree of action, nor indeed ought to have. You now comprehend that the roll is gradually formed by the repetition of the ſame operations on different parts of the leaf. But it often happens that the coarſer edges reſiſt too much; the inſect knows how to weaken them by gnawing them here and there. In order to form a *cone*, ſome more performances are neceſſary. The *roller* cuts with her teeth, on the leaf, the part that is to compoſe it. She does not detach it altogether from it; it would then want a baſe; ſhe only ſeparates that part which is neceſſary to form the foldings of the

cone.

cone. The part is properly a ſlip, which ſhe rolls as ſhe cuts it. She raiſes the cone on the leaf, almoſt in the ſame manner as we erect an inclined obeliſk. She fixes threads or little cables near the point of the pyramid; ſhe preſſes on them with the weight of her body, and thus forces the point to raiſe itſelf. You may form an idea of the reſt; the mechaniſm is the ſame as that employed in making a roll.

Theſe cells, in which the caterpillar lives, ſerve likewiſe as a retreat for the chryſalis. This latter would not probably be ſufficiently well accommodated with a bare covering of leaf. The caterpillar lines the cell with ſilk tapeſtry. Other ſpecies ſpin a cone for themſelves in it.

CHAP. VIII.

Inſects that are miners of leaves.

SOME leaves of plants are ſcarcely thicker than paper. Would any one imagine there were inſects ſkilful enough to provide a lodging in ſuch thin leaves as theſe, ſo as to ſhelter themſelves from the injuries of the weather? A leaf is to them a vaſt country, wherein they make roads for themſelves that are more or leſs winding; they mine in the parenchymia of the leaf, as our miners do in the earth. From hence alſo they have taken the name of *miners of leaves.* They are extremely common: ſome belong to the claſs of caterpillars; others to that of worms. They cannot bear to be naked; and it is for the ſake of covering themſelves that they inſinuate themſelves between the two foldings of a leaf. They find their ſubſiſtence there at the ſame time. They eat the parenchymia or pulp of

of it, and, in eating, trace out a way for themſelves. Some dig there ſtrait or crooked trenches. Theſe are *gallery* miners. Others mine round about them, in circular or oblong ſpaces, theſe are *miners* at large. Their teeth are the inſtruments they mine with; but ſome worm *miners* dig the parenchymia by means of two hooks reſembling our pick-axes. Several of theſe inſects ſpin, within the mine, the cone wherein they are to transform themſelves. Others quit the mine, and ſpin or metamorphoſe themſelves elſewhere. Butterflies that proceed from *mining* caterpillars, are little miracles of nature. She has laviſhed gold, ſilver, and azure upon them. She has even done better than this, and has aſſociated them with colours that are more or leſs rich; though we regret that ſhe has not performed theſe maſter-pieces in a more extenſive form.

But *miners* have ſomething ſtill more wonderful to offer to us. Beſtow your attention on thoſe vine leaves that are before you. They are pierced with *oval holes*, which ſeem to be made in them by a *gimblet*. The *mining* caterpillars bored theſe holes, by ſtripping two pieces of ſkin from the leaf, with which they make a cone: that cone is there placed perpendicularly on a vine-prop, at a pretty conſiderable diſtance from the leaf that furniſhed the materials. How was it cut, faſhioned, detached, and conveyed? Let us not vainly attempt to gueſs this: let us rather endeavour to ſurpriſe the induſtrious labourer on her working bench. She mines *by way of gallery*, and conſtructs her cone at the extremity of the gallery. It is compoſed of two pieces of leaf of an oval form, very thin, even, and like each other. The caterpillar prepares theſe places; makes of them a thin texture, by clearing them of the pulp; ſhe models them, lines them with ſilk, cuts them with her teeth as with ſciſſars, joins

joins and unites them. They already have no connection with the leaf, notwithſtanding which, the cone does not fall: the caterpillar has taken the precaution to ſuſtain it by ſome threads of the ſame ſpecies with its border. When the cone is finiſhed, the caterpillar applies herſelf to diſengage and tranſport it from its place. She has left a ſmall aperture at one end of it. She cauſes her head to come out at this opening, bears it forward, ſeizes a part of the prop with her teeth, and by an effort draws the cone to her. The threads that hold it give way, and the caterpillar carries her little houſe about with her as the ſnail does her ſhell. Behold her walking; her march is a new myſtery. It has been ſaid that all caterpillars have at leaſt ten legs: this is abſolutely without any, and ſhews us what an opinion we ought to entertain of ſuch naturaliſts. Let us lay in her way a finely poliſhed glaſs, placed perpendicularly. She is not in the leaſt retarded by this, but climbs over the glaſs as on a leaf. By what ſecret art is ſhe enabled to cleave to it, for ſhe has neither legs nor claws to grapple it? You have ſeen caterpillars that ſpin little heaps of ſilk which they fix themſelves to. Our *miner* † ſpins the like, at certain diſtances, according to the track ſhe is to paſs over. She ſeizes one of theſe heaps with her teeth, which becomes in part a ſupport for her; ſhe draws the cone to her, and carries it towards the little heap; faſtens it to it; thruſts her head forwards; ſpins a ſecond heap; fixes herſelf to it in the ſame manner as to the firſt; makes an effort to diſcharge the cone, which ſhe effects, drags it towards the new heap, faſtens it likewiſe to it, and this ſecond ſtep being taken unravels to you the ſecret of her ingenious mechaniſm. By this means ſhe leaves on the bodies over which ſhe paſſes little

† Chap i. of this part.

tracks

tracks of ſilk, which ſhe ſpins from ſpace to ſpace. When ſhe has arrived at the place ſhe is inclined to fix herſelf at, ſhe here ſtops the cone intended for an habitation, and places it in a vertical ſituation. There afterwards iſſues from it a very pretty butterfly, as richly cloathed, and of the ſame genus, as thoſe of other miners.

CHAP. IX

Falſe moths.

OTHER inſects live in great galleries of ſilk, which they lengthen and widen as they grow. They cover them with groſs matter, and frequently with their excrements. They conſtruct thoſe galleries on the various bodies they feed upon, and which differ according to the ſpecies of the inſect. The name of *falſe moths* has been given to all ſuch ſpecies as make thoſe incloſures. You are ſenſible, that thoſe of *true moths* are portable. The moſt remarkable falſe moths are ſuch as ſettle in bee-hives, and deſtroy the combs. They are without defenſive arms, and are only ſecured with a ſoft and delicate ſkin; notwithſtanding which nature has appointed them to live at the expence of a little warlike people that are well-armed, and equally well diſpoſed to defend their ſettlements. Our engineers have frequently recourſe to mines and ſap in the reduction of places. It is indeed abundantly neceſſary that our falſe moths ſhould excel in this kind of attack, and their works prove that they do. They never march but under cover. They ſcoop long trenches in the thick part of the combs, in what direction they think proper, wherein they are always in ſafety from the enemy. The galleries of this kind are lined within with a very

cloſe

cloſe ſilk tiſſue, and covered on the outſide with a thick layer of grains of wax and excrements. Thus the fine works of the laborious bees are deſtroyed in ſilence by an enemy which they are not able to diſcover, and that ſometimes compels them to abandon their hive. The falſe moths have no intention to procure honey: they never penetrate into the cells that contain it. They only eat the wax, and their ſtomach analyſes the matter which the chemiſt cannot diſſolve. When they have attained their full growth, they make a ſilk cone at the end of the gallery, which they never fail to cover with grains of wax.

Other falſe moths eſtabliſh themſelves in our granaries, where they multiply exceſſively. They covet our moſt valuable commodity. They connect together ſeveral grains of corn; they ſpin a little tube in the midſt of this heap, where they lodge. By that means they are always within reach of a plentiful ſtock of nouriſhment. They feed at their pleaſure on the grains of which they have been careful to form their caſe, and which are like a covering to it. When their metamorphoſis approaches, they abandon this caſe; they neſtle in the inner part of a grain, or in the little cavities they dig in the cielings: theſe they line with ſilk, and there tranſform themſelves into a chryſalis.

CHAP. X.

Of moths in general.

Domeſtick moths.

THERE are few inſects which claim ſo good a right to our admiration as thoſe that are equally ſkilful with ourſelves in making cloaths, and that undoubtedly

undoubtedly learned the art before us. Like us, they are brought forth naked; but they no ſooner come into the world, than they ſet about cloathing themſelves. They do not all dreſs in the ſame uniform manner, nor do they uſe the ſame materials in their cloathing. There is perhaps a greater diverſity with reſpect to this in the modes of different ſpecies of moths, than in thoſe of different people on the earth. This is a very intereſting ſight to the obſerver, which the contemplator of nature can only conſider, like the reſt, in a very general view. We have taken a tranſient ſurvey of *domeſtic* moths *: they well deſerve to have a farther degree of attention beſtowed upon them. The form of their dreſs is moſt convenient for them: it correſponds exactly with that of their body. 'Tis a little cylindrical caſe, which opens at both ends. The ſtuff is manufactured by the moth: the tiſſue or ground of it is compoſed by a mixture of ſilk and hair: but this would not be ſoft enough for the inſect, it is therefore lined with pure ſilk. Our woollen furniture and furs ſupply theſe moths with the hairs they employ in manufacturing their ſtuffs. They make a careful choice of theſe hairs; cut them with their teeth, and artfully incorporate them in the ſilk tiſſue. They never change their cloaths: thoſe they wore in their infancy, they continue to wear when arrived at maturity They can then lengthen or widen them as they find convenient. They meet with no difficulty in extending them; this they do by only adding new threads and hairs to each end. But the widening them is not ſo eaſy a matter. You have ſeen † that they proceed herein exactly as we do in the like caſe. They ſlit the caſe at the two oppoſite ſides, and ſkilfully inſert

* Part X. ch. 2. † Part XI. ch. 2.

two

two pieces of the width required. They do not ſlit the caſe from one end of it to the other: if they did, the ſides would ſtart aſunder too much, and be expoſed. They only ſlit each ſide about the middle of it. So that inſtead of adding two pieces or widths, they add four. Reaſon itſelf could not exceed this. Their dreſs is always of the colour of the ſtuff from whence it was taken. If therefore a moth, whoſe cloathing is blue, paſſes over a red piece of cloth, the widths will be red; ſhe will make herſelf a harlequin's habit, if ſhe paſſes over cloths or ſtuffs of ſeveral colours. They live on the ſame hairs they cloath themſelves with. It is remarkable that they are able to digeſt them; and it is ſtill more extraordinary that the colours do not ſuffer the leaſt alteration by digeſtion, and that their excrements are always of as fine a tincture as the cloths they feed on. Painters may collate from our moths powders of all colours, and all kinds of ſhades of the ſame colour. They make little journies: thoſe that ſettle in caſes, do not love to walk on long hairs, but cut all they meet with in their way, and are always provided with a ſcythe as they march. They reſt themſelves from time to time, when they fix this caſe with ſmall cords, and thus cauſe it as it were to ride at anchor. They faſten it more firmly, when they are diſpoſed to metamorphoſe themſelves. They cloſe up intirely both ends of it, in order to cloath in it, with the greater certainty, the form of the chryſalis, and afterwards that of the butterfly.

CHAP.

CHAP. XI.

Field and aquatic moths.

FIELD moths, from whoſe effects we have nothing to fear, greatly exceed the *domeſtic* moths in point of induſtry. They take the ſubſtance of their cloathing from the leaves of plants; but it becomes neceſſary for them to prepare this matter, and give it that lightneſs and flexibility proper for their garments. Theſe moths are of the ſpecies of *miners*; and they inſinuate themſelves betwixt the two membranes of a leaf, which are to them what a piece of cloth is to a taylor; with this difference, that the latter has occaſion for a pattern, and the moths can diſpenſe with the uſe of one. They remove from theſe membranes all the pulpy ſubſtance that adheres to them, which membranes they make thin and poliſh. They afterwards cut in them, thus prepared, two pieces, which are nearly equal, and like each other; they labour to give them the hollowneſs, curve, windings, and proportions which the form of their caſe requires, and this form is often of an exquiſite kind. They connect and unite them with incredible ſkill and propriety, and conclude by lining them with ſilk. They have then nothing to do but diſengage the cloathing from within the leaf where it was taken and cut, and that requires but a few efforts. Some of theſe caſes have little notches on the ſide of their backs, which are a great ornament to them, and make them ſeem to be much compounded. Theſe notches are no other than thoſe of the leaf from whence the caſes were formed. Field moths metamorphoſe themſelves in their cloathing, as domeſtic moths do in theirs. We have hitherto taken only a ſlight view of the induſtrious art of the *field* moths; we ſhall conſider

conſider them more attentively elſewhere, when we ſhall not be able to recover from our ſurpriſe at them. Beſides, the cloathing of theſe moths will not admit of being lengthened and widened; when it becomes too ſtrait, they make another.

Many *field* and *aquatic* moths (for the waters have alſo their moths) do not know how to prepare the ſtuff for their cloathing. Wherefore the matters which compoſe them are not ſuſceptible of any proportion. Bits of wood, little ſticks, fragments of leaves, pieces of bark, &c. placed on each other like tiles, compoſe the external cloathing of the caſe, which conſiſts of pure ſilk. At other times it is covered with gravel, pebble-ſtones, pieces of wood, little bits of reed, and ſmall ſhells either of muſcles or ſnails, and, what is ſcarce credible, the ſnails and muſcles continue to live in theſe ſhells; for, being in a manner chained to the caſe, they are obliged to follow the moth, that carries them wherever it pleaſes. Thus a moth in its cloathing does not appear unlike certain pilgrims. Thoſe that are covered with wood, gravel, ſtones, and other unweildy matters connected together, pretty nearly reſemble a Roman ſoldier in heavy armour. You rightly judge, that ſuch kind of clothes muſt needs be very roughly formed: but ſome of them nevertheleſs look very pretty, in which the ſymmetrical arrangement of the materials makes ſome amends for their extreme coarſeneſs. Aquatic moths reap ſome advantage by dreſſing themſelves in ſuch a ſtrange manner. They muſt be always in equilibrio with the water in the midſt of which they live. If their caſe prove too light, they add a little ſtone to it; if too heavy, they faſten ſome bits of reed to it. All theſe moths metamorphoſe themſelves in their caſe; ſome into butterflies, others into flies, and others into beetles.

Some *field* moths borrow no ſtrange matters to cloath themſelves with; they dreſs intirely in ſilk; but their tiſſue is much cloſer, finer, and more gloſſy, than that of the moſt beautiful caterpillars. It has a ſtill greater ſingularity; being compoſed of little ſcales, like thoſe of fiſhes, and which are partly placed on each other. The caſe has ſometimes for its laſt covering a kind of mantle, which almoſt intirely incloſes it, and is compoſed of two principal pieces, whoſe figure reſembles that of a *bivalve* or two-vaſed ſhell. Moths that procure the matter for their cloathing from their own fund, muſt be able to lengthen and widen it at pleaſure; the expence attending the obtaining of it was too great to admit of their making a new one as often as there ſhould be occaſion. So that they are able to enlarge it in a wonderful manner. They do not add *breadths* to it as the domeſtic moths do; but ſlit it from one part of it to another, according to its length, and immediately fill up the intervals with new threads, of a length proportioned to the ſpace required. This caſe, which is of a remarkable form, ſerves them likewiſe as a kind of cone, wherein they transform themſelves into butterflies.

CHAP. XII.

Reflections on theſe various proceedings of inſects.

YOU have taken a rapid ſurvey of the produce of a multitude of different inſects, and are with good reaſon aſtoniſhed at the prodigious variety contained in them, all relative to one and the ſame general end, and all of them likewiſe as much diverſified as thoſe of our artiſans or artiſts. How does it happen, that amongſt ſo many inſects as prepare themſelves for their metamorphoſis, ſome hang by their

their hind-part, others faſten themſelves with a girdle, whilſt others make themſelves cones. How comes it to paſs, that of thoſe that conſtruct theſe cones, ſome form them of pure ſilk, and others compoſe them of matter of different kinds? Why is the form of theſe cones ſo various in thoſe of different ſpecies? Wherefore do ſome inſects ſo artfully roll up the leaves of plants and others only faſten or fold them together? How can we account for the mining of theſe leaves by ſome of them only, and that the reſt ſhould not all mine them in the ſame manner? In ſhort, how ſhall we aſſign a reaſon why the moths are not all clothed in the ſame dreſs?

All theſe *wherefores*, and a thouſand others that may be formed on the productions of nature, are ſo many enigmas propoſed to beings that are baniſhed into a corner of the univerſe, and whoſe ſight, as ſhort as that of the mole, can only perceive the neareſt objects, and the moſt direct and moſt ſtriking relations. The works of inſects are the dernier reſults of their organization, which organization correſponds with the part they are to act in the grand machine of the world. They are indeed but very ſmall parts, but theſe parts concur to produce one general effect, by their being interwoven with more important ones. So that the girdle ſpun by a caterpillar, has its relations to the univerſe, as Saturn's ring alſo has. But how many different parts are there interpoſed betwixt the girdle and the girdle, and betwixt Saturn and the worlds of Syrius? If the world be one whole (and how can we doubt of it, after ſo many excellent proofs of an univerſal chain* ?) the girdle of the caterpillar will then be likewiſe connected with the worlds of Syrius. What an infinite mind muſt that be which

* Part i. chap. 3 and 7.

can comprehend with a ſingle glance this immenſe chain of various relations, and can perceive them all to reſolve into *unity*, and unity into its CAUSE?

It behoves us to remain in the place that has been alloted for us, from whence we can only diſcover ſome links of the chain. One day we ſhall diſcover more of them, and ſhall ſee them more diſtinctly. Mean while we may conſider theſe proceedings of inſects, ſo diverſified and replete with induſtry, as an agreeable ſpectacle exhibited by nature to the eyes of the obſerver, that furniſhes him with an inexhauſtible ſource of reflective pleaſures and uſeful inſtruction. He is led to the AUTHOR of the univerſe by the thread of the caterpillar, and he admires in the variety of their means, and in their tendency to the ſame end, the fecundity and wiſdom of the ORDAINING MIND.

This ſight becomes ſtill more intereſting, when the obſerver undertakes to bewilder inſects, and draw them from their natural track. They then ſhew him reſources, which he had not himſelf foreſeen, and that ſurpaſs his expectation. When falſe moths of the wax ſpecies are in want of wax, they can make galleries of leather, parchment, or paper. A caterpillar has been ſeen to conſtruct a cone of little pieces of paper which have been given to him, and that have been cut at pleaſure. It has taken hold of them with the teeth and fore-legs, tranſported them to the place where it intended to fix, ranged them there, faſtened them with threads, laid ſome of them edge-wiſe, others flat, forming of the whole, it is true, an aſſemblage that appears a little ſtrange, but anſwering perfectly to a cone. It would have given it a more regular figure, had it worked with materials ſuited to its ſpecies. Ere we had learnt to prepare and dreſs woollens and ſkins of animals, it is probable the *domeſtic* moths were not without cloathing.

cloathing. They were then perhaps habited in the ſame manner as the *field* moths. This reflection leads us to endeavour to oblige different moths to cloath themſelves differently. It would likewiſe be curious to oblige others to go naked. They would in that caſe probably find ſomething that would ſerve them for dreſs. A ſeries of the generations of theſe moths would inform us, whether they could at length be taught to forget to cloath themſelves, &c. &c.

CHAP. XIII.

Proceedings of ſhell-fiſh.

The river muſcle.

WE do not expect to make any material diſcoveries from *ſhell-fiſh* that are ſhut up in an almoſt ſtony incloſure, which conſtitutes part of their being; they ſeem very ſtupid; but notwithſtanding the ſmall ſhare of induſtry they diſcover, we are greatly indebted to them for it. They are not all ſo ſenſeleſs as they appear to be: we ſhall with pleaſure contemplate the proceedings of ſome of them.

You need not be informed that muſcles live in a *bivalve* ſhell. The two parts are united by a kind of griſtle, which the muſcle puts in motion, in order to open and ſhut the ſhell at its pleaſure. The ſtructure of the animal is not our preſent object of inquiry; we will ſee what it is able to perform. We are treating of *river muſcles*. There is one whoſe ſhell lies flat on the ſand. In a little time this ſhell will be pretty far from the place to which it now appears to adhere. The river will not occaſion it to ſhift its place; the muſcle will

tranſport itſelf. You endeavour to find out her method of effecting it, which you are not able to penetrate. Leave her to herſelf, and follow her. She opens her ſhell a little, and puts forth a kind of tongue or fleſhy trunk. I muſt inform you, that her deſign is, to place the ſhell on its edge: ſhe alſo lies on one of her ſides, which ſide is almoſt flat, and the ground horizontal. How then will ſhe be able to raiſe the ſhell, and place it on its edge? Her only inſtrument is her trunk. With this trunk ſhe digs up the ſand round the ſhell, makes a little ditch, and cauſes the ſhell to fall into it, which by this means becomes placed almoſt vertically on its edge. The muſcle puſhes her trunk forwards, and extends it as far as ſhe can, ſhe fixes the extremity of it in the ſand, and by this means draws the ſhell to her till it arrives to its perpendicular elevation; by this method it is placed intirely on its edge. But the muſcle is diſpoſed to go forwards. She draws a furrow or groove in the ſand with her trunk; ſhe faſtens herſelf to it as at firſt; draws the ſhell to her, which ſlips into the groove, that keeps it on its edge. Thus the muſcle makes a path for herſelf, and by her mechaniſm diſcovers to us a reſource which before we had no conception of. Her trunk ſerves her as hands and feet, and ſupplies all her neceſſities: ſo that it is rather a hand or a foot, than a real trunk.

CHAP.

CHAP. XIV.

Other ſhell-fiſh.

The Tellina.

DIVERS ſpecies of ſea ſhell-fiſh, ſuch as *muſcles*, &c. whoſe ſhell is *bivalve*, move by nearly the ſame kind of mechaniſm. Moſt of them are furniſhed with two pipes, by means of which they ſuck in the water, and which they take great care to keep raiſed above the veſſel they are accuſtomed to ſink into more or leſs. Some ſpurt out the water to the diſtance of ſeveral feet. That particular part which in ſome performs the progreſſive or retrograde motion, very much reſembles a real leg with a foot joined to it; but this leg is a Proteus, which aſſumes all kinds of forms to ſupply the neceſſities of the animal. It does not only make uſe of it to crawl with, ſink into a veſſel, or retire from it; but employs it with much greater ſkill to perform a motion that one would not imagine a ſhell-fiſh capable of. A ſhell-fiſh that leaps, muſt appear very extrordinary. 'Tis a tellina that you are now ſeeing. You may obſerve that ſhe has placed the ſhell on the top or point, in order to leſſen the frictions. She ſtretches out her leg as far as poſſible; ſhe cauſes it to take hold of a conſiderable part of the circumference of the ſhell, and, by a ſudden motion, ſimilar to that of a ſpring that is ſlackened, ſtrikes the ground with her leg, and thus leaps to certain diſtance.

CHAP. XV.

The cutler.

THE *cutler* never creeps: it penetrates perpendicularly into the ſand. It there digs itſelf a hole, or a ſort of cell, which is ſometimes two feet long, in which it goes up and down at pleaſure. Its ſhell, whoſe form a little reſembles that of the handle of a knife, has occaſioned it to receive the name of *cutler*. It is compoſed of two long pieces, hollow like a gutter, and joined together by membranes. The body of the animal is incloſed in a caſe. The part whereby it exerciſes all its motions, is placed in the center. This is principally deſigned to perform the office of a leg, and acquits itſelf exceeding well. It is fleſhy, cylindrical, and pretty long. The extremity of it, when neceſſary, can roll itſelf up like a ball. View the cutler when extended on the ſand. You behold it working, in order to pierce into it. It thruſts out its leg at the lower end of the ſhell; ſtretches it, and cauſes the extremity of it to aſſume the form of a ſhovel that is ſharp on both ſides and terminates in a point. It directs it towards the ſand, and applies the edge and point for introducing it farther. After the aperture is made, it extends its leg ſtill more, and cauſes it to penetrate deeper into the ſand: he bends it like a hook, with which taking hold of a ſupport, he draws the ſhell to him, forcing it upright by degrees, and afterwards cauſes it to deſcend into the hole. Is he diſpoſed ſtill to continue ſinking? He thruſts his whole leg out of the ſhell; fixes in the ſand the ball which is then at its extreme part; immediately contracts this leg; his large head, which is ſtrongly fixed in the hole, being

being leſs inclined to reaſcend than the ſhell is to go downwards, the cutler deſcends into the ſand, which is his firſt ſtep into it; he has nothing to do but to repeat the ſame operations, in order to advance farther and farther into it. Is he diſpoſed to go up again to the ſurface? he puſhes forth the ball, and at the ſame time makes an effort to extend his leg; the ball, which is averſe to a deſcent, preſſes the ſhell towards the top of the hole. It is pretty remarkable, that the cutler, which lives in ſalt water, dreads the touch of ſalt. If a pinch of it be caſt into his hole, he will come out of it immediately. If he be caught, and afterwards permitted to re-enter his cell, it will be in vain to throw ſalt into it, ſince he will not quit it on that account. It is ſaid by ſome, that he remembers having been taken; and this is ſo true, that when people do not endeavour to catch him, he may be made to come out at one's pleaſure, by throwing ſome freſh ſalt into the hole. It ſeems, then, that he is aware of the ſnare that is laid for him, and is unwilling to ſuffer himſelf to betaken by it.

CHAP. XVI.

The Dails or Pholas.

CAST your eyes on this ſtone, which I have juſt now taken up from the ſea-ſhore. A ſhell-fiſh fixes his habitation in it. Were I not to add that it is alive, you would be apt to imagine I was going to ſhew you a petrification, and your curioſity would not be excited by ſo common a thing. Obſerve, that on the ſurface of the ſtone there is a very little hole; 'tis by that the ſhell-fiſh has entered, and you may judge of the ſmallneſs of it by that of the aperture. We will break the ſtone aſunder,

that we may ſee the extraordinary animal that dwells in it. How great muſt your ſurprize be! you behold a great ſhell-fiſh, near three feet in length, whoſe ſhell is formed of three ſmooth pieces joined together by a ligamentary membrane. It is lodged in a great cavity, that is hollow like a funnel or ſection of a cone. The upper part of the cone is in the little hole you ſee on the ſurface of the ſtone. This ſhell-fiſh is a *dail* or pholas. How could it be able to pierce ſo hard a ſtone? or how go through ſo narrow a paſſage? Draw near this clayey ſhell whieh the wave has juſt left. It is pierced through with a multitude of ſuch holes as you ſee in the ſtone you have in your hand. All theſe holes are inhabited by young dails, which are only a few lines long. They had then no occaſion to penetrate into a hard ſtone. Simple clay, or ſuch as is moiſt, makes but little reſiſtance. But the ſea inſenſibly converted this clay into ſtone: the dail, which firſt of all found himſelf lodged in a ſoft earth, afterwards perceived that he was neſtled within a ſtone cell. The progreſſive motions of theſe ſhell-fiſh is without doubt the ſloweſt in nature, for it bears an exact proportion to their growth. As they grow, they advance deeper. So that the meaſure of their growth is that of the progreſſive motion From thence it happens that the cell is an inverted funnel. We have ſeen that the cutler can come out of his hole when he pleaſes: the dail never quits his; nor indeed can he; ſince the form of this kind of cell will not admit of it. All that he can do is, to ſtretch out two pipes at the opening of the hole, with which he receives and rejects the water. The cutler does the ſame. You are impatient to be informed of the inſtrument with which the dail hollows his cell. This inſtrument has no edge to it: it is purely fleſhy, and ſhaped like a lozenge. You rightly judge

that

that he muſt proceed very ſlowly in his work, but you would not perhaps think that he is capable of piercing the petrified clay: at leaſt it is very certain that he can penetrate through wood. It is highly probable that dails live a long while, ſince it is a conſiderable time before the clay petrifies.

CHAP. XVII.

Divers ſea-inſects or animals.

Nettles.

WE will quit ſhell-fiſh for a time, and reſume them hereafter. Divers inſects or animals of the ſea will likewiſe entertain us with the wonders of their Author. Let us beſtow on them the attention they deſerve; what we are about to relate concerning them, will be found well deſerving of a chapter in natural theology.

On the rocks near the ſea-ſhore you may perceive little fleſhy maſſes, of the ſize of an orange, whoſe form is like that of a counter-bag, and pretty nearly reſembling that of a cone when cut. All theſe maſſes ſeem immoveable and connected with the rock by their baſe. Some of them are rough, others ſmooth. We have juſt now compared them to a bag or purſe in which counters are put, but this bag is not folded together, and is likewiſe without ſtrings. They are nettles * that you ſee; a very ſingular kind of animals, that demand a cloſer attention. The body of the animal is in effect incloſed within a ſort of fleſhy purſe, of a conic figure. At the top of the cone is an opening, which the nettle increaſes or contracts at pleaſure.

* So called by the antients, who imagined they produced the ſame effect on the hands as nettles do; which is falſe.

Let us conſider the nettles that we have now before us: there is one that opens and unfolds itſelf like a flower: It has put forth an hundred and fifty fleſhy horns, like thoſe of ſnails, diſtributed in three rows round the aperture. You remark that little water-ſpout iſſue from theſe horns; conſequently they do not perform the ſame functions as thoſe of ſnails; you judge that they are analogous to the pipes of dails, cutlers, and other ſhell-fiſh which you have ſeen, and this judgment is very true. You alſo remark, that the form of all theſe nettles varies greatly, that their baſe is ſometimes circular and ſometimes oval, and that the height of the cone varies according to the dimenſions of its baſe. It riſes or falls as the baſe grows narrower or wider. Touch one of theſe blown nettles: ſee with what quickneſs it cloſes and contracts itſelf. But you perceive no progreſſive motion: are the nettles then always condemned to paſs their whole life fixed to the ſame ſpot? The ancients thought ſo. What are we to think of them? About an hour ago, this large nettle, which you ſee on your right-hand, touched this point of the rock: obſerve that it is now at above an inch diſtant from it. You are ſurpriſed that you did not perceive it walk, for you looked at it more than once; the reaſon of this is, becauſe its progreſſive motion is as ſlow as that of the hand of a clock. We may very naturally be curious to know how the nettle performs it. All its body is externally furniſhed with various orders of muſcles. Thoſe of the baſe go like rays, from the centre to the circumference; others deſcend from the top towards the baſe. Theſe muſcles are alſo canals, full of liquor, which iſſues out on pricking them. They are emptied and filled at the pleaſure of the nettle. By the exerciſe of theſe muſcles or canals, the progreſſive motion we are deſirous of knowing is performed.

Let

Let us follow the nettle when ſhe is diſpoſed to go forwards. Her baſe is circular. She ſwells the muſcles that are on that ſide whither ſhe is tending. She injects her liquor into them, which, by inflating, lengthens them. They cannot extend themſelves unleſs the edge correſponding with the baſe ſhifts its place, and advances a little way. At the ſame time ſhe looſens the oppoſite muſcles, and empties their canals. They contract. This they cannot do, except the edge of their correſponding baſe goes in a little, and exactly in the ſame degree as the oppoſite one projects. Such is the mechaniſm whereby the firſt ſtep of our nettle is performed. In order to make a ſecond, ſhe cauſes the baſe again to receive a circular form, by puffing up equally all the canals: ſhe afterwards repeats the ſame operations we have juſt taken a ſlight view of.

The whole progreſſive motion of nettles is not confined to this. They have another method of walking, which more nearly reſembles that of inſects. They are able to make uſe of their horns like legs. But theſe horns are on the upper part of their body: the nettle is fixed by its baſe againſt the rock: how do their horns perform the office of legs? The nettle you are following will ſhew you the method. She turns herſelf upſide down; the baſe abandons the rock, and the cone is placed on its top. All the horns ſhoot forth, and you ſee them fix themſelves to the rock. They are glewy and rough to the touch: for which reaſon they meet with no difficulty in faſtening to it.

Would you believe that an animal which is intirely of a fleſhy nature, and is provided with no inſtrument to open or pierce the ſhells, feeds upon ſhell-fiſh? Nettles that are but a middling ſize ſwallow great ſhell-fiſh, and it is difficult to conceive how they are capable of being lodged within the

nettle It is true, the latter being intirely fleſhy is ſuceptible of a great diſtenſion. It is a ſort of very ſupple purſe, that may be ſtretched occaſionally. The opening of the purſe is properly the mouth of the nettle. Its inſide not being tranſparent, one cannot ſee what paſſes therein, or by what means the nettle voids the ſhell-fiſh. The moment ſhe has ſwallowed it, ſhe cloſes herſelf. Look at this young nettle that is ſhut up quite cloſe: ſhe has juſt ſwallowed a pretty large ſnail, and is buſy in voiding and digeſting it. She is now opening herſelf again, and diſcharging the empty ſhell. On the ſide of her is another nettle which beſpeaks your attention: ſhe has ſwallowed a great muſcle, and is making ineffectual efforts to void the ſhell. She is not able to effect it: the ſhell preſents itſelf in an unfavourable poſition at the aperture, and you begin to be in pain for the unhappy nettle. She has a reſource that you did not imagine. Caſt your eyes towards the baſe; the ſhell is evacuated thro' a large wound; the nettle is delivered from it by that means, and is no more affected by the great gaſh made thereby than we are by a ſcratch.

All nettles do not procure a diſcharge by ſo violent a method: they have another, which they commonly uſe with ſucceſs. They turn themſelves inſide out like a glove or ſtocking, ſo that the edges of the opening, which reſemble lips, fold themſelves on the baſe. The mouth is then of a prodigious width, and the bottom of the purſe almoſt uncovered. One may perceive in it a kind of *ſucker*, which is probably the inſtrument by which the nettle voids the ſhell. She empties then by the mouth the reſidue of the body ſhe feeds upon.

Nettles do not thus ſhift themſelves merely to get rid of heterogeneous bodies; they put themſelves into the ſame poſture when they bring forth. They

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are viviparous. The young are produced completely formed; and we ſee nettles in miniature appear. The aperture through which they paſs is ſo wide, as to admit a multitude of them at the ſame time. Notwithſtanding which, they always come forth ſingly. They are at firſt incloſed in certain folds concealed at the bottom of the purſe.

Do not theſe nettles, which you cannot ſufficiently admire while you obſerve them, recal to your remembrance the idea of thoſe famous *polypus's with arms* *, that have preſented ſo many wonders to your view? They are likewiſe membraneous throughout, extremely voracious, and furniſhed with horns, that ſerve them for legs and arms. They alſo caſt out the reſidue of their aliment by the mouth. The lips of this mouth too may be turned backwards on the body. Theſe are ſo many marks of analogy.

Do nettles in like manner reſemble polypus's by the ſingular property they have of being multiplied and grafted by ſlips? The moſt modern experiments have put this beyond all doubt. Of a ſingle nettle, divided according to its length or width, are made two or three, which at the end of a few weeks are perfect and complete. They may likewiſe be grafted; but it will be neceſſary to have recourſe to *ſeaming*. You are now no longer ſurpriſed at the conſolidation of that enormous wound made at the baſe of a nettle that iſſues out thereat. A wound of this nature is nothing when compared to that which another animal ſuſtains when cut in pieces, without ceaſing to live and multiply in each piece. Nettles then may be called a ſpecies of *polypus's with arms* of a monſtrous ſize, or, if you prefer the expreſſion, *polypus's with arms* are a ſpecies of very minute *nettles*.

* Part viii. chap. 15.

Let us quit theſe rocks that ſwarm with nettles, and betake ourſelves to that little creek where the ſea is very calm. Stoop a little, and obſerve the ſurface of the water. What do you perceive? A kind of greeniſh jelly floating upon it. Its form is like that of a broad muſhroom. It is near two feet in diameter. Take a piece of it betwixt your fingers; handle it for a few minutes: you will ſee it diſſolve into water. The heat of your hand was ſufficient to melt it. Does it enter into your thoughts that this jelly is a real animal, and even a ſpecies of nettle? It has been called *wandering nettle*, becauſe it never fixes, and floats from one ſide to the other. Its convex ſurface preſents us only with an infinite number of little grains or nipples. But its inferior ſurface, which is concave, is extremely organized: In that we may ſee a great number of canals, which are regularly diſpoſed, and made with great art, ſome being circular, and others diſpoſed regularly, like the felloes of a wheel, and which are full of a watry liquor, which paſſes from one to the other.

This ſtrange animal wanders about in the ſea. It is ſpecifically much heavier than water. He cannot therein ſuſtain himſelf, without the aſſiſtance of a ſpontaneous motion, which is worth obſerving, and cannot be ſeen but in places where the water is calm. It is ſo in this little creek on the extremity of which we are ſitting. Look with attention on the ſurface of that jelly which offers itſelf to your view. Obſerve that it has certain motions, which you are tempted to compare with thoſe of the *ſyſtole* and *diaſtole*. However they are not the ſame. Their only end is to cauſe the nettle to float. You ſee that in the ſyſtole kind, the ſurface of the animal becomes very convex, and that in the diaſtole it becomes ſuddenly flat and wide. Such is our glutinous nettle's method of floating. When dried in

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the ſun, it is reduced almoſt to nothing. We imagine that we ſee a little piece of parchment or very tranſparent paſte. There is no room to doubt that this ſpecies of nettle multiplies, like the reſt, by ſlips; but I do not know that there has been any experiment made concerning this. A jelly muſt be attended with greater eaſe in regenerating itſelf than organiſed bodies of the ſame genus, that are of a more firm and cloſe conſiſtence.

CHAP. XVIII.

Stars.

THERE are no regular or ſtrange forms of which the animal kingdom does not afford us models. The moſt intereſting ſight to the eye of a naturaliſt muſt undoubtedly be that of ſuch prodigiouſly varied forms as theſe, that are at the ſame time ſo proper to induce him to conceive the moſt exalted ideas of the inexhauſtible fecundity of nature. Here is an animal whoſe form is preciſely that by which we paint the ſtars in the firmament. How can we do otherwiſe than give it the appellation of *ſtar?* It is nearly flat. From the middle of its body proceed four or five rays, which are almoſt equal and reſembling each other. Its upper ſurface is covered with a hard, callous, and very rough ſkin. In the centre of the inferior ſurface is placed the mouth, which is provided with a ſucker, that the ſtar makes uſe of to imbibe the ſubſtance of the ſhell-fiſh ſhe feeds upon. Five ſmall teeth or pincers hold it confined whilſt ſhe ſucks them, and perhaps aſſiſt in the opening the ſhell. The legs of the ſtar are a real curioſity. They are joined to her inferior ſurface, and diſtributed with ſymmetry in four rows, each conſiſting of ſeventy-ſix feet; ſo that each

each ray is furniſhed with three hundred and four feet, and the whole ſtar with fifteen hundred and twenty. However, incredible to think! notwithſtanding ſuch a prodigious number of feet, the ſtar goes but little faſter than the muſcle, which has only one. After this, let us now haſten to decide, from the utmoſt ſtretch of our capacity, concerning their particular ends. Here I refer my reader to the reflection I made at the beginning of the 14th chap. of the 8th part. Theſe legs, which have been ſo exceſſively multiplied in ſtars, perfectly reſemble the horns of the ſnail, both by their figure, conſiſtence, and exerciſe. When the ſtar is diſpoſed to walk, ſhe ſpreads her legs as the ſnail does her horns, and with the extremity of them ſeizes the various marine bodies on which ſhe crawls. She commonly puts forth only one part of her legs; the remainder are kept in reſerve againſt thoſe neceſſities which may occaſionally happen. The mechaniſm which preſides over their motions is an illuſtrious proof of a CREATIVE MIND. Let us open one of the rays by ſlitting it lengthwiſe, and we ſhall by that means diſplay the principal ſprings of the machine. An almoſt cartilaginous partition, made in the form of vertebræ, divides the whole ray. In every part of this partition you perceive two rows of little balls, like pearls of the fineſt water. Suffer not the pleaſure you feel in contemplating them, to deprive you of a moſt intereſting fact: I beg of you to remark, that the number of theſe little balls is preciſely equal to that of the legs. Count both of them. Thus you ſee that each ball anſwers to a leg. You think you can diſtinguiſh a limpid liquor in theſe balls; you are not deceived in this. Preſs your finger upon them; they empty themſelves; the liquor paſſes into the correſponding legs, and they immediately extend themſelves. The ſtar then need

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only preſs the balls in order to ſpread the legs. But they are capable of contraction, and when they contract themſelves, they force the liquor back again into the balls, from whence it may be driven afreſh into the legs, to procure a progreſſive motion.

You are inclined to conjecture, that theſe legs, which pretty nearly reſemble thoſe tubes through which divers kinds of ſhell-fiſh reſpire, ſerve likewiſe for the ſame uſes. But nature, who has been ſo laviſh in providing the ſtar with legs, has been alſo liberal in beſtowing on it the organs of reſpiration. She has even multiplied them in a greater degree. They are very ſmall conic tubes, diſpoſed in knots, and produce an equal number of little water-ſpouts.

Amongſt our ſtars, you obſerve there are ſome which have only two or three rays, and by looking more narrowly at them, you diſcover ſeveral very minute rays, that ſeem juſt beginning to ſhoot out. Is it from hence, you aſk me, that the ſtars likewiſe multiply by ſlips? Are animals, that are formed of a repetition of ſuch a great number of parts, both outward and inward, regenerated like polypus's, whoſe ſtructure appears ſo ſimple to us? Nothing is more true, and the ſtars you are now looking at, will afford you a proof of it. Theſe animals often chance to loſe two or three of their rays, and they are no more affected by this loſs than polypus's are by parting with ſome of their arms. We may mangle ſtars, or cut them in pieces, but cannot deſtroy them by that method. They will recover from their ruins, and each piece become a new ſtar.

This admirable reſource has been particularly neceſſary to a ſpecies of ſtars whoſe rays are very brittle, and ſerve them inſtead of legs. In beſtowing legs with ſo much complaiſance on other ſtars, nature might ſeem to have forgot this, and in ſome meaſure to have deformed it, had ſhe provided it with

rays

rays as flexible as the tail of the lizard, which ſhe pretty ſkilfully makes uſe of to creep with at the bottom of the ſea.

CHAP. XIX.

Hedgehogs.

THESE are animals on which a ſtill greater ſhare of pains and workmanſhip have been beſtowed; I had almoſt ſaid, wherein is diſplayed a much more abundant degree of profuſion. Sea hedgehogs, like the land ones, derive their names from their prickles. But thoſe of the former are quite different from ſuch as belong to the latter. The prickles of the firſt are their legs. Let us take a ſurvey of the exterior part of theſe animals, where nature has been pleaſed to collect in ſo laviſh a manner the organs relative to progreſſive motion.

The form of theſe hedgehogs is that of a round button. It is hollow within, and its ſurface is elaborately wrought. We might compare the workmanſhip of them to that of certain copper or *wire* buttons. A multitude of tubercles, like breaſts, repreſent on them, by their diſpoſition, little triangles, that divide the whole ſurface of the button in different areas. Theſe triangles are ſeparated by ſtripes, which are regularly ſpaced, pierced with holes, and diſtributed with great ſymmetry in ſeveral lines. Theſe holes paſs through from one part to another the whole thickneſs of the ſkeleton, for the body of our hedgehogs is a kind of bone-box. Each hole is a ſocket, wherein is lodged a fleſhy horn, like thoſe of a ſnail, and ſuſceptible of the ſame motions. There are therefore as many horns as holes, and there are reckoned to be at leaſt three hundred. The hedgehog, like the ſnail, makes uſe

uſe of her horns for feeling the earth, and the various bodies it meets with in its paſſage. But it particularly employs them to faſten with and caſt anchor. The tubercles are the baſes of many prickles or bags, and their number amounts to at leaſt two thouſand one hundred. So that there is hardly any part of the body of a hedgehog that is deſtitute of a leg. It can for that reaſon walk as well on the back as on the belly; and in general, let it be in what poſture it will, it has always a great number of legs ready to carry it, and horns to fix it with. The legs it uſes with the greateſt eaſe are thoſe which ſurround the mouth; but, when it pleaſes, can walk by turning round on itſelf like a wheel. On the back or top of the button, is another aperture, which is thought to be the anus. This then is an animal that is provided with at leaſt thirteen hundred horns, and two thouſand one hundred legs. What a great number of muſcles muſt it require to move ſo many horns and legs? How many fibres and fibrillæ muſt there be in each of theſe muſcles? What an aſtoniſhing multiplication of parts in this little animal! What regularity, what ſymmetry, and even harmony in their diſtribution! What variety in their exerciſe!

When the hedgehog would advance, he draws himſelf forwards with thoſe legs that are neareſt the place he would go to, and puſhes himſelf towards it with the oppoſite ones. All the reſt remain at that time in a ſtate of inaction. At the ſame time that one part of his legs are at work, the horns that are neareſt to them exert themſelves to ſound the way, or find anchorage for the animal.

CHAP.

CHAP. XX.

Bernard the hermit.

SHELL-FISH are produced with their cloathing. The ſhell they bear grows with them and by them. The animal under conſideration, which is taken for a kind of cray-fiſh, comes into the world without a ſhell, but nevertheleſs has need of one in order to cover the greater part of its body; whoſe thin and delicate ſkin would ſuffer too much from being naked. Has nature then behaved to it as a ſtepmother, by denying it ſo neceſſary a garment? By no means: as ſhe is beneficent towards every other animal, ſo has this likewiſe been the object of her attention. It is true, ſhe has not provided it with a ſhell; but has made it ample amends for that defect, by enabling it to cloath itſelf with one. Taught by ſo great a miſtreſs, our hermit has the ſagacity to take up his lodging in the firſt empty ſhell he meets with. He applies himſelf indifferently to all that are of a ſpiral conſtruction. He often retires ſo far into them, as not to be perceived, whereby the ſhell appears empty. Is he inclined to ſhift his habitation? he then ſtretches out his claws or pincers, like thoſe of a crab, and ſeizing with them the neareſt bodies, draws the ſhell to him, at the ſame time twiſting himſelf round the chinks in the walls or ſtairs of his dwelling, to prevent his being expoſed. If the ſhell ſhould prove too narrow, he quits it, in order to ſeek for another, more ſuitable to his bulk. It is ſaid, there ſometimes happen conteſts between our hermits about a ſhell, and that victory is decided in favour of him who has the ſtrongeſt claws. Our battles have ſcarcely ever a cauſe of equal importance for their object.

CHAP. XXI.

Shell-fiſh that ſpin.

Muſcles and primæ marinæ.

THE title of this chapter no doubt ſurpriſes you. You did not expect to meet with this new mark of induſtry in ſhell-fiſh, that promiſed ſo little. You have been already greatly aſtoniſhed at the ſkill diſplayed in the progreſſive motion of ſeveral of them: your amazement will be redoubled when you learn that ſome of them can ſpin; and you are impatient to ſee them at work, and to judge of their labour. Let us walk on the ſea-ſhore. You there diſcover a number of muſcles, ſome by themſelves, and others joined in companies. Conſider them a little more attentively: you will obſerve that ſome of them are faſtened to ſtones or to each other, by a great number of ſmall ſlender ſtrings. Let us ſelect one of theſe muſcles from the reſt, that we may obſerve it more cloſely; we ſhall by that means be the better able to diſcover their operations. Here is one of them endeavouring to fix itſelf to this ſtone that is near the ſurface of the water. The ſhell is partly open: it has thruſt out from it a kind of very ſupple tongue, which it lengthens and contracts alternately. Remark, that it often applies the ends of it to the ſtone, and immediately draws it back again into the ſhell, that it may again put it forth the next moment. From the root of this kind of tongue there iſſue certain threads, which are equal in ſize to an hair or hog's briſtle. Theſe threads part from each other as they come out, and their extremity ſticks to the ſtone. Theſe are as ſo many ſmall cables which hold our muſcle at anchor. There are frequently

quently an hundred and fifty of theſe little cables employed in mooring a muſcle. Each cable is ſcarcely two inches long.

The muſcle herſelf has ſpun all theſe cords. In contemplating the progreſſive motion of the river-muſcle, and ſome other ſhell-fiſh *, you greatly admired the ſkill with which they made uſe of their tongue. You have ſeen that this part alone ſerves them at the ſame time for both legs and arms. The tongue of our ſea-muſcles likewiſe performs the ſame functions; but, with reſpect to theſe, this little inſtrument is of a much more ſurpriſing nature. It not only ſerves them, as it does other ſhell-fiſh, for arms to faſten themſelves with, and for legs to creep with; but is alſo the ſpinning inſtrument which produces thoſe numerous threads by means of which the muſcle reſiſts the impulſe of the waves. From the root of the tongue to its extremity there is a groove, which divides it according to its length into two equal parts. This groove is a real channel, furniſhed with a great number of ſmall muſcles, that open and ſhut it. In this channel is contained a viſcous liquor, which is the matter of the threads emitted by the muſcle. At its firſt appearance this channel is exactly cylindrical, and is properly ſpeaking the place where the threads are moulded. The various motions the tongue of the muſcle we are obſerving gave itſelf a minute ago, all tended to fix it to the ſtone. Thoſe threads which are the whiteſt and moſt tranſparent are ſuch as are newly ſpun. She has not yet finiſhed anchoring herſelf, wherefore you perceive her tongue is again extending about two inches, and the tip of it drawing towards the ſtone. The viſcous liquor runs in the channel, and arrives at the extremity of it. This

* Ch. 13, 14, of this Part.

liquor is now conſolidated, and become a cylindrical thread. The muſcle ſticks the end of this thread to the ſtone; but is deſirous of applying it by a wider ſurface, in order to render it more adherent. For that purpoſe, ſhe procures to it, with the tip of her tongue, that little paſte which you obſerved, and that is extremely ſenſible. Her buſineſs now is to extend another cable to ſome diſtance from the laſt. The tongue therefore muſt quit this latter, in order to work elſewhere. How will ſhe be able to effect this? The channel opens itſelf to its utmoſt length, and diſcharges the thread. The tongue being diſengaged from this thread, quickly draws itſelf together, re enters the ſhell, and the next moment again iſſues from it, to fix a new cable a little farther off.

Did you take notice of a mark of ſkill expreſſed by our muſcle? She has juſt now ſpread the firſt thread; to aſſure herſelf of the goodneſs of it, ſhe immediately puts it to the proof; drawing it ſtrongly towards her, as though ſhe would break it. It has reſiſted this effort, and, ſatisfied with the experiment, ſhe has proceeded to ſtretch out the ſecond thread, which ſhe has tried like the firſt.

Theſe cords which the ſea muſcles ſpin with ſo much art, are in reality as ſerviceable to them as cables are to a ſhip that is at anchor. You aſk me, whether they can weigh anchor? Divers experiments ſeem to prove that they are not endued with that ingenuity. Doubtleſs it was not neceſſary for them. But they ſometimes drive with their anchors; it therefore behoves them to be able to tranſport themſelves from one place to another, and to have freſh cables in reſerve.

Thus the ſea has its ſpinners as well as the earth. Muſcles are at ſea the ſame that caterpillars are on land. There is nevertheleſs a remarkable difference between

between them. The work of caterpillars anſwers exactly to that of gold wire-drawers. The ſilk thread is moulded by paſſing through the mouth of the ſpinner, and the caterpillar gives it what length ſhe pleaſes, which in certain cones conſiſts of ſeveral hundred feet *. The labour of muſcles may be rather compared to that of workmen who caſt metals. The ſpinning inſtrument of theſe ſhell-fiſh is a real mould which does not only determine the thickneſs of the thread, but alſo its length, which is always equal to that of the ſpinning inſtrument or tongue.

The *primæ marinæ*, which are a ſpecies of very large muſcles, are more dextrous ſpinners ſtill. Their threads, which are at leaſt ſeven or eight inches long, are extremely fine, and curious works are made with them. If muſcles are caterpillars of the ſea, primæ are its ſpiders. The threads of the primæ ſerve, like thoſe of muſcles, to moor them with, and defend them from the agitation of the waves. They are prodigiouſly numerous, and, being united, form a kind of tuft or ſkain, weighing about three ounces. The inſtrument that prepares and moulds them, reſembles, in the eſſential properties of it, that of other ſhell-fiſh of this kind: except that it is much larger, and the groove that divides it lengthwiſe is much narrower. At the root of it there is a membranous bag, compoſed of ſeveral fleſhy layers, that ſeparate the ſilk layers from whence the tuft reſults.

* Chap. iv. of this part.

CHAP.

CHAP. XXII.

Shell-fiſh and other animals that faſten themſelves by a ſort of glue or ſtony juice.

IF all kinds of ſhell-fiſh and ſea-animals have not been enabled to moor themſelves with as much ſkill as muſcles and pinnæ, nature has made them amends for that by affording them means that are no leſs efficacious. Before we quit this ſhore, let us ſtop a little while and examine this ſmall ſhell-fiſh, which you ſee faſtened to this rock. It is a *goat's eye*, or a *limpet*. Its ſhell, which conſiſts of one piece only, is made like a conic chapiter, under which the whole body is ſheltered, as under a roof. The animal can raiſe or lower this covering as it pleaſes. When it lowers it, the body is intirely concealed, and it reſts immediately on the ſtone. A large muſcle that occupies the whole extent of the ſhell, and that is as it were the baſe of it, faſtens the animal to this ſtone. Try to diſengage it from it; you are not able to effect it. It is nevertheleſs only fixed to the ſtone by a baſe of an inch and half in diameter. Let us hoiſt a cord round the ſhell; and ſuſpend a weight of twenty-eight or thirty pounds to this cord, the ſhell-fiſh will not quit its hold till after ſome ſeconds, and you are ſurpriſed that ſo ſmall an animal ſhould be endued with ſo great a power of adheſion. You are curious to know from whence he derives this: you examine the ſtone, and it appears to you to be finely poliſhed, whereupon your aſtoniſhment is redoubled. Can it be that the muſcle is able to inſinuate itſelf into the inſenſible parts of the ſtone? Divide the animal tranſverſely: it ſtill adheres as ſtrongly as before. Is it that it cleaves to the ſtone as two

pieces of poliſhed marble cleave to each other? But pieces of marble eaſily ſlip each other; and you cannot cauſe the ſhell-fiſh ſo to do. This then is the ſecret cauſe of that adheſion which aſtoniſhes you. The muſcle is furniſhed with a viſcous humour, which agglutinates it to the ſurface of the ſtone, and which is ſenſibly felt by touching it with the finger.

But the goat's eye has not been condemned to remain its whole life affixed to the ſame place. It is neceſſary for it to go in ſearch of its food. There is one now creeping on the rock: its great muſcle ſerves him inſtead of legs, and performs the ſame functions as that you have been made acquainted with in the ſnail. The goat's eye then can diſengage himſelf when he pleaſes. It is able to break thoſe ſtrings which are with difficulty disjoined by a weight of eight-and-twenty pounds. Moiſten your finger, and ſtroke the muſcle with it; the natural glutinous ſubſtance, with which it is endued, can no longer retain its hold. This glue is diſſoluble by water. The whole ſurface of the muſcle abounds with little ſeeds, filled with a diſſolvent liquor. When the animal is diſpoſed to ſhift his quarters, he need only preſs his numerous glands, the diſſolvent iſſues from them, and the cords are broken.

The goat's eye has but one certain proviſion of gluey matter. If it be looſened from its place ſeveral times together, its ſtock will be exhauſted, and it will not fix any more.

This method of mooring is common to divers ſea-animals. It is particularly ſo to *nettles* *. Its whole ſkin is one entire maſs of glue, which diſſolves very ſpeedily in aqua vitæ. It is with this

* Chap. i. of this part.

abundant

abundant quantity that theſe extraordinary animals faſten themſelves to the rocks.

Star-fiſhes alſo fix themſelves by the ſame method *. A viſcous matter is conducted to the extremity of that ſpecies of horns that ſerve them inſtead of legs, and which they have many hundreds of. Though they are very feeble, theſe legs become ſtrong ties to them by means of the glue that exſudes from them, and when they are once faſtened, it is eaſier to break than ſeparate them. The horns of hedgehogs are exactly of the ſame nature †.

All theſe adheſions are voluntary, and depend ſolely on the good pleaſure of the animal. He joins or disjoins himſelf as circumſtances require. But there are other adheſions, which are altogether involuntary. Sea-worms, that are called *pipe-worms*, are incloſed in a round tube, of a ſubſtance reſembling that of ſhells, and faſtened to ſtones or hard ſand, or even to other ſhell-fiſh. This tube follows the turnings of the ſurface to which it is fixed. The worm never quits this ſhell, which he lengthens or widens as he grows. They recall to your remembrance the falſe moths ‡: this may be termed, if you think proper, a *falſe moth* of the ſea. It emits from its whole body a ſtony juice, which is the matter whereof the tube is formed.

Other worms of this ſpecies, whoſe juice is not of a ſtony nature, but abounds in glutinous matter, make uſe of it for collecting round them grains of ſand, bits of ſhells, &c. &c. and this ſhell of inlaid pieces is notwithſtanding wrought in pretty exact proportion.

Oyſters, and many other ſhell-fiſh, adhere by a ſtony liquor to the bodies whereon they reſt, and

* Chap. 18. of this part. † Ibid. chap. 19. ‡ Chap. 9. of this part.

are often by this means cemented to one another. Of ſuch a ſpecies is that univerſal cement which nature makes uſe of, as often as ſhe would erect in the ſea, or eſtabliſh therein a ſhell-work againſt the violent motion of the waves.

CHAP. XXIII.

The proceedings of fiſhes.

WE have acquired but little knowledge of the induſtry of fiſhes. They are not ſufficiently within our reach. The greateſt part of them inhabit gulphs that are inacceſſible to our reſearches. We do not preſume to think, that all their intelligence is confined ſolely to the devouring of each other. Their migrations are alſo as remarkable as thoſe of birds. They may have need of a kind of genius to enable them to chaſe their prey with ſucceſs, and elude the purſuit of their enemies. The *cuttle fiſh* ſcatters about, at a proper ſeaſon, a black liquor, which troubles the water, and hides her from the ſight of ſuch fiſh as attempt to take away her life. Perhaps this liquor may be ſerviceable to her in ſeizing with the greater eaſe thoſe ſhe feeds upon. Other fiſhes can with abundance of art penetrate into very hard ſhells, and extract from thence the fleſhy ſubſtance contained in them. We are not yet acquainted with the uſe the *ſword-fiſh*, the *ſaw-fiſh*, and the *narval* or *unicorn-fiſh*, make of thoſe enormous inſtruments they wear at the end of their ſnouts; but they are undoubtedly able to handle them. Has not the *cramp-fiſh*, which ſo ſuddenly benumbs the hand that touches it, a very remarkable method of providing for its ſafety, and an excellent art to propoſe to the meditation of the natural philoſopher? The *flying-fiſh*, when purſued by

by others, darts out of the watry element to take refuge in the air, where it is for a time ſuſtained by its great fins.

The manner by which fiſhes *ſpawn*, is likewiſe a very intereſting thing. Several during that period quit the ſeas and lakes, and enter into the rivers. The male ſports with the female, and after yielding themſelves up to their chaſte amours, re-enter their antient abodes.

It is well known that carp are capable of being tamed, and that they will haſten, like fowls, at a certain ſignal, to receive food from the hands of their provider.

What do we not owe in this reſpect to the dolphin? What have not the ancients, who were by nature lovers of the marvellous, boaſted of his ſkill, his agility, his paſtime, his tenderneſs towards mankind, his conſtancy, and even gratitude! But we muſt leave the poets to celebrate this Pylades of the ſea.

It is probable that fiſhes are of all other animals endued with the longeſt lives. We have ſeen carp of an hundred and fifty years old. Fiſhes tranſpire and harden but little: they have, properly ſpeaking, no bones. But they live in a ſtate of perpetual warfare. They all devour or are devoured by others. Thoſe who attain to their age, muſt acquire an extenſive knowledge of things relating to the ſea. Such Neſtors as theſe may be able to procure us ſome good memoirs of the ſecret hiſtory of a people ſo little known.

CHAP. XXIV.

Of the proceedings of birds.

WE have taken a ſlight view of the emigrations of birds, and have conjectured that they depend principally on the winds *. An exact naturaliſt at Malta has aſſured himſelf of this. All his obſervations prove, that the ſame ſpecies always change their climate with particular winds. In April the *ſouth-weſt* wind brings into that iſland a ſpecies of *plovers*, and the *north-weſt*, *cardinals* and *quails*. Nearly at the ſame time, *falcons*, *buzzards* and other birds of *prey*, migrate with the *north-weſt* wind, without ſtopping, and depart in October with the *ſouth* and *weſt*. In ſummer, the *eaſterly* wind conducts the ſnipes to Malta, and, towards the autumn, the *north* and *north-weſt* bring thither numerous ſquadrons of *woodcocks*. Theſe birds cannot fly, like the *quails*, before the wind; ſince the *north* wind, which might carry them into Barbary, obliges them to remain in the iſles. *Quails*, on the contrary, emigrate before the *wind* from one country to another. The *ſouth-eaſt* enables them to paſs, in the month of March, from Barbary into France. They return from France in September, and go to Malta by a *ſouth-eaſt*. The winds, therefore, are the ſignals employed by nature for reminding divers kinds of birds of the time of their departure. In obedience to this voice, they ſet out, and follow the direction it points out to them.

The taſk would be endleſs, were we to go through the proceedings peculiar to each ſpecies of birds; to follow birds of *prey* in their almoſt intelligent

* Part ix. chap. 13.

chaſe;

chaſe; *aquatic* birds in their ingenious methods of fiſhing; *domeſtic* birds in their little houſewifry; *nocturnal* birds in their gloomy retreats, &c.

I will not then detain you by raiſing your admiration at the long tongue of the *wood-pecker*, the ſpring that puts it in motion, and its manner of darting it into the holes of trees, in order the more ſkilfully to ſeize the little inſects lodged within them.

What a ſeries of intereſting circumſtances would not the conſtruction of their neſts alſo preſent us with! How great would our admiration be at the ſight of theſe little buildings, ſo regularly conſtructed, and compoſed of ſo many different materials, collected one after another with ſo much pains and exactneſs, and wrought together and arranged with ſo much induſtry, elegance, and propriety, by an animal that has only a cartilaginous bill and two feet for its inſtruments! A chaffinch or gold-finch's neſt would take us up whole hours in contemplating it. We ſhould inquire where the gold-finch could be able to furniſh itſelf with a cotton ſo fine, ſilky, and ſoft, as lines the inſide of its pretty neſt, and that makes for it ſo downy and warm a bed. After many reſearches, we ſhould at laſt diſcover, that by covering the ſeeds of certain willows with a very fine cotton, nature has prepared for the gold-finch the down ſhe employs with ſo much art. We ſhould never be weary of conſidering that kind of embroidery with which the chaffinch ſo agreeably adorns the outſide of his neſt, and, on viewing it more narrowly, we ſhould perceive that it is owing to an infinity of little liverworts, artfully interwoven together, and diſtributed and applied with the utmoſt propriety over the whole ſurface of the neſt. The colour of theſe liverworts, which is moſt commonly that of the bark of the tree on which the neſt is ſituate, would

indicate to us, that the chaffinch ſeems to intend that her neſt ſhould be confounded with the branch that bears it.

We ſhould obſerve other ſpecies that build their neſts in holes of trees, in the clefts of rocks, and in cavities that they dig under ground; we ſhould ſee ſome of them working in wood, others in maſonry. The ſwallow would afford us a familiar example of the latter: we ſhould ſee with pleaſure how ſhe prepares her morter, how ſhe tempers it, and with what aſſiduity ſhe applies it to its proper uſe, in order to give to her little manſion all the ſolidity that is requiſite for it.

But the neſts that would ſtrike us with the greateſt ſurpriſe are thoſe which certain Indian birds ſuſpend to the branches of trees, that they may ſecure themſelves from the inſults of divers inſects. We ſhould aſſure ourſelves that the marvellous in this inſtance was greatly exaggerated, were we told, that there were neſts of this kind with two apartments, one for the male, and the other for the female. On examining the matter more cloſely, with the eyes of a curious obſerver, we ſhould find that this pretended apartment for the male is only an old neſt, that of the preceding year, to which the bird has judged it more convenient or expeditious to add another, than to make an entire new one from it.

CHAP. XXV.

Of the proceedings of quadrupeds.

The rabbet.

SHALL we viſit the retreats of *rats*, *field mice*, *badgers*, *foxes*, *otters*, *bears*, &c. We ſhould undertake thereby too tedious a journey, whilſt more intereſting

intereſting objects beſpeak our attention. Let us limit ourſelves to the procedures of the *rabbet* and *monkey*, as the moſt curious, after thoſe of the beaver, which we have largely treated of *.

The *rabbet* and *hare*, which bear ſo near a reſemblance to each other both in their exterior and interior part, teach us not to truſt to appearances. They eaſily couple together, and produce nothing. They are therefore two very diſtinct ſpecies, notwithſtanding this affinity.

Moreover, the feeble hare contents herſelf with the lodging ſhe makes for herſelf on the ſurface of the earth. The more induſtrious rabbet penetrates into the earth, and there procures for herſelf an aſſured aſylum. The male and female live together in this peaceable retreat, fearleſs of the fox or bird of prey. Unknown to the reſt of the world, they ſpend their days in happineſs and tranquillity, and taſte in domeſtic ſweets the moſt delightful pleaſures of life.

The hare might alſo dig the earth, but does not, neither does the *clapper* † rabbet dig it, ſince he has no occaſion; his dwelling place being provided for him, he behaves himſelf as if he was ſenſible of it. The warren rabbet ſeems to know that he is unprovided, and procures for himſelf a lodging. Clapper rabbets, with which they ſtock warrens, form like the hare, but at the end of a few generations they begin to burrow. Do not the inſults of their enemies, the injuries of the weather, and the various inconveniencies inſeparable from an erratic life, admoniſh them of the neceſſity of forming for themſelves ſubterraneous retreats? But to perceive the relations thoſe retreats have to their own preſervation, and to judge that they will ſhelter them

* Part xi. chap. 26, 27. † The domeſtic rabbet.

from all the inconveniencies they labour under, is an operation of the ſoul that borders on *reflection*, if it be not reflection itſelf. And how can we allow reflection to brutes? Would it not be more philoſophical to ſuppoſe, that the kind of life the clapper rabbets lead, weakens and impairs in ſome meaſure their conſtitution, relaxes their organs, and deprives them of the power of digging into the earth? The open air re-eſtabliſhes nature in them, and reſtores to them a vigour proper to the ſpecies: but this re-eſtabliſhment requires a longer or ſhorter time, and it is not complete till after a certain number of generations. A family of ſavages brought up with us would there ſoon degenerate, and the ſecond generation would not be able to endure the painful labours and ſevere manner of life of their anceſtors, &c.

When the hare is ready to kindle, ſhe digs for herſelf a new burrow. This is a winding trench, or one made in zig-zag. At the bottom of this trench ſhe works a great cavity, lining it with her own hairs. That is the very ſoft bed ſhe prepares for her young. She does not quit them during ſeveral of the firſt days; and only goes out afterwards to procure nouriſhment. The father at that time knows nothing of his family: he does not dare to enter the burrow. When the mother goes into the fields, ſhe often takes even the precaution to ſtop up the entrance of the burrow with earth ſteeped in her urine. When they are grown ſomewhat larger, the leverets begin to brouſe the tender graſs. The father at that time acquires a knowledge of them, takes them up in his paws, licks their eyes, poliſhes their hair, and diſtributes his careſſes and cares equally amongſt them all.

Obſervations that appear to be exact, prove that paternity is greatly reſpected amongſt hares. The grandſire

grandſire continues to be the chief of the whole numerous family, and ſeems to govern it like a patriarch.

CHAP. XXVI.

The monkey.

THE tricks of the *monkey* are known to every body. No one is ignorant with what facility ſhe is tamed, and taught to dance and ſhew poſtures on a ſtaff. Her ingenious proceedings on the tops of the Alps, where ſhe fixes her abode, in the midſt of ſnow and froſt, are not ſo generally known.

Towards the month of October, ſhe enters into winter quarters, and ſhuts herſelf up for the remainder of the ſeaſon. Her retreat is worthy of obſervation. It is performed with ſuch art and precautions, as ſeem to be the reſult of a kind of intelligence, did not intelligence inceſſantly combine and vary its plans. On the brow of a mountain, the induſtrious monkey eſtabliſhes her dwelling. It is a great gallery dug under-ground, and made like a Y. Theſe two branches, which have each of them an opening, terminate at a kind of *amen-corner*. Such is the apartment of the monkey. One of the branches deſcends below the apartment, according to the ſloping of the mountain; it is a kind of aqueduct that receives and carries off the excrements and filth. The other branch, which riſes above the habitation, ſerves for an avenue and place to go out at. The apartment is the only part of the gallery which is horizontal. It is lined with a thick layer of moſs and hay. It is certain that monkeys are ſociable animals, and that they work in common on their lodging. They amaſs during the ſummer ample ſupplies of moſs and hay. Some

it is ſaid mow the graſs, others gather it, and by turns they ſupply the office of a cart to convey it to the ſtorehouſe. One of the monkeys lies on his back, opens his paws to ſerve inſtead of *racks*, ſuffers himſelf to be loaded with hay, and drawn by the reſt, who hold him by the tail, and are careful to prevent the carriage being overturned on the road. Their feet are armed with claws, which enable them with great eaſe to dig into the earth, which they perform with wonderful celerity. As ſoon as they have made a hollow place in it, they throw behind them the dirt they extract from the mine. They paſs the greateſt part of their life in their habitation: they retire into it during the rain, or on the approach of a ſtorm, or at the ſight of ſome imminent danger. They ſeldom quit it except in fine weather, and go but a little way from it. Whilſt ſome are ſporting on the turf, others are buſy in cutting it, and a third party are acting as ſcouts on the eminences, to give notice to the foragers, by a whiſtle, of the enemy's approach.

During the winter, monkeys eat nothing, being unable to do ſo. The cold benumbs them, ſuſpends or greatly diminiſhes perſpiration, and other excretions. The fat with which their belly is well provided paſſes into the blood, and reſtores it. We might affirm that they foreſee their lethargy, and are appriſed that they ſhall then have no need of nouriſhment; for they do not think of hoarding up proviſions, as they do materials for furniſhing and lining the inſide of their lodging. Their cuſtom, in this particular, correſponds with that of the ants.

CHAP.

CHAP. XXVII.

Of the language of beaſts.

THIS ſubject has not been philoſophically enough treated of. As we allow underſtanding to brutes, this comes but little ſhort of granting them the uſe of ſpeech alſo, and of furniſhing us with their dictionary. Their diſcourſes have been handed down to us in an exact reſemblance to thoſe travellers have given us of ſome ſavage nations. Here truth has been intermixed with abundance of falſehood. Let us endeavour to make the ſeparation.

When we inquire whether the beaſts have a language, it will be neceſſary carefully to diſtinguiſh two ſorts of languages, the *natural* and the *artificial*. In the firſt ſort ſhould be ranged all the *ſigns* the animal gives for knowing what paſſes within him. But if we will confine ourſelves to *ſounds* only, the natural language will be an aſſemblage of *inarticulate* ſounds, uniform in all the individuals of the ſame ſpecies, and ſo connected with the ſentiments they expreſs, that the ſame ſound never repreſents two oppoſite ſentiments. *Artificial* language, on the contrary, will be a collection of *articulate* and *arbitrary* ſounds, which have no other affinity with the ideas they repreſent, than what *inſtitution* or convention gives them; inſomuch that the ſame *ſound* may a be ſign of very different and even oppoſite ideas.

Artificial language is properly what we term *ſpeech*. Man is the only animal that *ſpeaks*, and this admirable prerogative gives him dominion over all other animals. By means of ſpeech, he preſides over all nature, aſcends to its DIVINE AUTHOR, contemplates, adores, and obeys him. By ſpeech, he

he acquires the knowledge of himſelf, becomes acquainted with the beings that ſurround him, and converts them to his uſe: he is enabled to ſay, *Myſelf*, judge of his relations, conform himſelf to them, and thereby augment his happineſs. By ſpeech, he becomes a truly ſociable being; and thoſe ſocieties he forms, he governs by laws which he creates, changes, or modifies, as times, places, and circumſtances admit.

The brute being limited to *natural* language, is ignorant of every thing except his neceſſities, and the objects that may gratify him: but a multitude of ſenſations are connected with theſe various neceſſities, and have all, or almoſt all of them their *natural* ſigns. The ſpecies of the ſigns, their number, uſe, the order in which they ſucceed, the manner in which they are varied and combined, conſtitute the genius of the language of different animals, and furniſh the naturaliſt with an inexhauſtible ſource of curious obſervations, ingenious reſearches, and intereſting particulars: but if he would avoid error, he will not draw from this plentiful ſource, without the aſſiſtance of ſound logic.

The obſervations that prove that brutes have a *natural* language, are very numerous. We ſhall only be embarraſſed by the choice of them. We will not reſtrain this language to *ſounds*: we will join with it all thoſe ſigns by which the brute expreſſes what he feels. It is not neceſſary to go farther for ſtudying this language: a poultry-yard is the ſchool where we may be the beſt inſtructed in it. Let us liſten with an attentive ear to domeſtic animals, and take them for our teachers.

We will follow this hen that is guiding her chickens. Has ſhe found any thing? ſhe calls them to take part of it: they hear, and haſten to her immediately. Have they juſt now loſt ſight of this beloved

beloved parent? their plaintive cries expreſſively teſtify their troubles and wants.

Obſerve alſo the different cries of the cock, when a man or a dog enters the yard; when he diſcovers a hawk or any other object that affrights him; or laſtly when he calls his hens together or anſwers them.

What mean theſe ſcornful ſounds uttered by the turkey-hen? behold her young ones hide themſelves and crouch the ſame moment. One would imagine they were dead. Their mother looks towards the ſky, and redoubles her lamentations. What does ſhe there diſcern? a black ſpeck, that we are hardly able to diſtinguiſh, which is a bird of prey, that could not elude the vigilance and penetration of this parent, ſo deeply inſtructed by nature. The enemy diſappears: the hen gives a joyful ſhout: the alarms ceaſe, the little ones ariſe, and you now ſee them all collected round their dam, and enjoying their pleaſures.

Let us obſerve ducks, when they are inclined to take the water. Does it not ſeem as though they agreed among themſelves by reiterated noddings of the head, analogous to thoſe we make uſe of when we expreſs our approbation?

The cat, by his various mewings, ſignifies to his maſter his wants, to his female his love, and to his rival his anger.

Hear this female cat, that ſolicits her young to quit the garret where they were brought up, and to go down to the lower apartments, in order to partake with her of the advantages of this new abode. Obſerve her likewiſe playing with them. She has lately caught a mouſe: ſhe calls them; they run at her voice. She releaſes to them the living prey, and teaches them to ſport with it. What harmony in their play! what vivacity, what variety in their motions!

motions! what expreſſiveneſs in their geſtures, in their diſtortions, in their attitudes! What a diſplay of mind in all this! Pardon me this expreſſion, which my logic would in vain reject.

The language of the dog, the moſt expreſſive of all, is ſo various, ſo copious, and ſo rich, that it would of itſelf furniſh a large vocabulary. Who can remain inſenſible of the method by which this faithful domeſtic teſtifies the exceſſive joy he feels at the return of his maſter? He leaps, dances, goes from and returns to him, moves rapidly and with gracefulneſs round this beloved maſter, ſtops ſuddenly in the midſt of his career, looks at him with eyes full of tenderneſs, licks him by ſeveral repetitions, reſumes his courſe, diſappears, re-appears the next moment to lay ſomething at his feet, geſticulates, barks, and declares to all preſent his great good fortune; his joy burſts forth in a thouſand different places, and a thouſand ways; he can no longer contain himſelf, but redoubles his barking; one would think he was going to ſpeak; but what difference between the tone he now uſes and that he will aſſume in the night-time, when, placed as ſentinel at the door of the dwelling, he eſpies a thief! How different alſo is this laſt one from that he utters at the ſight of a wolf! Follow this dog to the chace: what expreſſiveneſs in all his motions, and particularly in thoſe of his tail! What diſcreet ardour, what regularity, what ſagacity, what conformity with the huntſman! What art does he employ to cauſe himſelf to be heard, to modify in a ſuitable manner his allurements, to diverſify his indications! A hare is ſtarted; the cry of the dog ſucceeds, and who can miſtake the redoubled ſounds he then echoes forth!

I walk by the ſide of a wood: I hear two birds anſwering each other. I ſee them gradually approach;

proach: I perceive they are two goldfinches: after having hopped ſome time from bough to bough, I perceive they place themſelves together, begin to bill, and proceed to little amorous inticements; their careſſes are redoubled; nothing can be more expreſſive: the happy couple unite. The male warbles in a low tone; the female hears him, and anſwers him by intervals. They are now to ſeparate no more, and both labour in concert to build the neſt appointed to receive the fruit of their amours. This being completed, the female has laid, and ſhe ſits on her eggs. The male attends nigh to her, and ſeems to endeavour to charm by his melodious accents the irkſomeneſs of *incubation*. The young are hatched; both parents jointly provide for their education, and take care of them by turns. I hear them calling for food; they have received it, and are quiet.

I hunt with a *bird-call*, and make uſe of an owl for that purpoſe. A ſwallow perceives it, cries, and flutters for ſome time around the mournful bird, and diſappears. In the ſpace of a quarter of an hour I ſee ſquadrons of ſwallows flocking to him, which oblige me to abandon the chace. Did the firſt ſwallow then go and ſound the alarm?

I enter the city. I hear a dog barking very loud, and almoſt without interruption: other dogs preſently join him; and all of them continue to bark inceſſantly. I enquire into the cauſe of their being thus aſſembled as a pack of hunters: I diſcover a man cloathed in a kind of uniform, leaning on a ſtaff. This man is one of the officers appointed by the police to poiſon and deſtroy the dogs at a certain time of the year: theſe animals know, and return him war for war.

CHAP.

CHAP. XXVIII.

Continuation of the ſame ſubject.

IF we deſcend from the ſuperior ſpecies to ſuch as are of an inferior claſs, and ſtop a while to conſider inſects, we ſhall find, that ſome of them are not unſkilled in the manner of deſcribing their little paſſions, and expreſſing their pleaſures and neceſſities. The amours of *ſpiders*, *demoiſelles*, or *dancing-birds*, and *butterflies*, would preſent us with many ſtriking marks that would leave us no room to doubt that the male and female have a method of underſtanding each other, which is indeed a very expreſſive one. Their cunning paſtime, various turns, and little wiles, prove to us that they are not novices in that language which all thinking beings poſſeſs more or leſs, and whoſe *ſigns* are almoſt always equivocal. We ſhould ſee the male ſolicit for a long time by his ſports, his careſſes, his conſtancy, thoſe favours which ſeem to be only denied to him at firſt in order the more ſtrongly to excite his paſſion and deſires. We ſhould obſerve the *queen bee* proſtitute herſelf to the *drones*, triumph over their indolence by her repeated allurements, occaſion the death of him ſhe ſhall have thus overcome, endeavour by her careſſes to reſtore him to life, and continue faithful to him even after death. Would not the prepoſſeſſion and aſſiduities of the *neuters* towards this queen, ſo neceſſary to the community, the kind of homage they pay her, contribute alſo greatly to ſwell the bulk of a dictionary of inſects?

As ſoon as we are become in a ſmall degree acquainted with the admirable compoſition of the organ of the voice of man, and alſo of that of quadrupeds and birds, we ſhall not ſo much as queſtion whether

whether ſuch organs were given them for the purpoſe of making ſounds and modifying them. The imagination is almoſt bewildered at the ſight of ſuch a prodigious number and variety of parts as compoſe the ſtructure of theſe wonderful organs, that are at the ſame time *wind* and *ſtring* inſtruſtruments. Theſe inſtruments are ſo aptly formed as to render ſounds peculiar to the ſpecies, ſo that if any one ſhould blow into the *trachea* of a ſheep or a dead cock, we ſhould imagine that we heard the voice of the animal itſelf. The *graſhopper* would furniſh us with wonders of this kind, which we ſhould not expect to meet with amongſt inſects. Were we not to limit the word *voice* to that air which is modified by the tendinous fibres of the *glottis*, and the other parts of the *larynx*, the graſhopper would have a *voice*, and the organ of this voice would appear almoſt as admirable as that of the voice of quadrupeds and birds. Let us not reſiſt the inclination we may have of entering into a detail ſo conducive to convince us that the moſt minute productions of nature are the work of that ADORABLE MIND, which is ſo conſpicuouſly diſplayed, as well in the little as in the great.

The graſhopper is a kind of *ventriloquus* creature: the organ of his voice is ſeated in the belly. The male only ſings; the female is mute, and it is probable the muſic of the male is not diſpleaſing to her. On the belly of the latter are two ſcaly plates, which are nearly circular, connected on one ſide by ligaments, and moveable on the other. They may be raiſed up; and to prevent that to too great a degree, they are with-held by two little pegs. If we lift up theſe plates, we are immediately ſtruck with the apparatus they unfold, and cannot but acknowledge that there is a determinate end in the formation of them, analogous to that we ſo clearly

diſcover

diſcover in a *larynx* or *glottis*. We at firſt perceive a great cavity, that is agreeably bordered in is upper circumference, and divided into two lodges by a triangular piece. At the bottom of each lodge there is a kind of mirror of the fineſt poliſh, which, being viewed obliquely, ſhews all the colours of the rainbow. Theſe ſeem to be two glaſs windows, through which one may diſcern the interior part of the animal. But theſe windows have each of them a ſhutter, that commonly covers them, which is one of thoſe ſcaly plates above-mentioned. Beneath each ſhutter there is a little prop that ſupports it, and prevents its ſinking too deep into the cavity.

You have already had a deſcription of many of the parts employed for enabling the graſhopper to ſing, and yet theſe are only the outward parts of an organ, whoſe inward and really eſſential ones we ſhall now proceed to give ſome deſcription of. Beſides the lodges adorned with mirrors, there are two little intrenchments in the great cavity, which are lined with a very elaſtic membrane, regularly furrowed, and deſtined to perform the functions of the tympanum. This has occaſioned theſe inſtruments to be called the *drums* or tympana of the graſhoppers. If a feather be drawn over the ſkin of theſe tympana, the graſhopper will be made to ſing; and the ſame will happen in a graſhopper that has been long dead, as well as in a living one. The furrows or regular folds of the elaſtic membrane are ſo many little ſonorous inſtruments, which have each their peculiar ſound. The air being agitated and modified by theſe inſtruments, afterwards reſounds in the lodges, where it is likewiſe modified by the different parts contained in them, in like manner as it is modified in quadrupeds, and even by the cavities of the mouth and noſe. Two great muſcles, formed from the union of a prodigious

digious number of ſtreight fibres, are appointed to put in motion the ſonorous furrows, which is the immediate cauſe of a cry that ſeems to be ſo grating to our ears. We are aſtoniſhed that nature ſhould put herſelf to ſuch a great expence to produce it; ſhe has been at a much greater in effecting the braying of the aſs; and, with reſpect both to one and the other, I think there was no neceſſity for her to conſult our ear. But the organ of the voice ſuppoſes an organ relative to that of the hearing: has the graſhopper then ears? does the male agreeably entertain thoſe of the female? or does he pleaſe himſelf with his ſong, or at leaſt with the exerciſe it occaſions him? We know nothing poſitive concerning this. The ſeat of hearing is not eaſily diſcoverable in inſects. Doubtleſs all are not deprived of it. The lizard and frog have ears, and they are nearly allied to inſects. Similar or analogous organs have been ſo diverſified in the animal kingdom, that it might not be thought ſtrange, were we to ſee the ears of inſects an hundred times without being able to know them. Beſides, we ought not to forget, that nature frequently makes uſe of the ſame inſtrument for various ends. Does not the tongue of a muſcle ſerve her at the ſame time for arms, legs, and an inſtrument for ſpinning *?

Animals that are produced and live in ſociety, that labour as it were in concert on the ſame work, are ſuch to which language ſeems to be moſt neceſſary. In effect, being called to form only one and the ſame family, mutually to comfort each other in their neceſſities, and to aſſiſt one another in their labour, what means could be deviſed more ſuitable than this to anſwer ſuch a deſtination? We

* Chap. 13. and 21. of this part.

have

have likewiſe obſerved ſome particularities amongſt animals, that ſeem to prove that they hear. We have ſeen * that monkies, when on guard, give their companions, by a whiſtle, the ſignal for flight. Beavers have a ſignal analogous to this: they ſtrike with violence on the water with their tail, and are all of them warned thereupon to provide for their ſafety. There are a thouſand inſtances, which would be tedious and unneceſſary to enumerate. But may we conclude from hence, that the works which theſe animals build in common are in like manner directed by a language peculiar to them? It ſeems there is no need in this caſe to have recourſe to ſuch a method. A compariſon will ſet my thought in a clear light.

Fifty architects are aſſembled in the ſame place to work together in the conſtruction of an edifice. They are incapable of ſpeaking to each other; are all dumb from their birth; but all of them have before their eyes a plan of the edifice, and have received the ſame diſpoſitions, and the ſame inſtruments for executing it. They are all endued with the ſame talents, and the ſame degree of underſtanding. The ſame ideas that are in the head of one, are equally found in the heads of the reſt. So that all of them judge and act uniformly in each particular caſe, and always in a determinate relation to this caſe. The materials which ſome of them have collected, the others apply to the work. The part which the firſt has begun, the ſecond proceeds with, a third and fourth finiſh and perfect. There is no contradiction, no diverſity of ſentiments, and no confuſion in their mode of acting, becauſe the ideas, will, and means are preciſely the ſame in all. Will this ſuffice to repreſent to us what paſſes in the republics of *ants*, *bees*, *beavers*, &c.?

* Chap. 26. of this part.

Be

Be this as it may, we cannot but admit that brutes have a *natural* language: a hundred and a hundred obſervations concur to confirm it. They not only inform us of what they experience, but we are alſo enabled to govern them as we pleaſe, by the mere help of the voice. Certain ſounds, which have frequently entered their ears, and have always ſtruck them under ſuch circumſtances as are proper for making a ſtrong impreſſion on the brain, have been deeply engraven there; inſomuch that on hearing theſe ſounds repeated, the idea of the thing or action annexed to them occurs to them immediately, &c. The method of training up *domeſtic* animals, and that whereby *wild* animals are tamed, furniſh numberleſs examples of this.

The vulgar imagine that brutes are taught to ſpeak: they are not aware, that to *ſpeak*, is to connect our *ideas* with *arbitrary* ſigns that *repreſent* them. The phraſes which the parrot repeats with ſo much exactneſs, do not prove that he has any ideas annexed to the words he pronounces: he could pronounce equally well the terms of the moſt abſtracted ſciences. Who does not ſee that this is an exerciſe purely *automatical?* If we have been able to teach ſome domeſtic animals to diſtinguiſh the characters of the alphabet, to join them together, to compoſe words of them, to mix colours, match them, &c. &c. all theſe facts, and an hundred others of the ſame kind, that aſtoniſh the vulgar, barely prove that the brain of animals is capable of forming *aſſociations* of *ſenſible* ideas. This is evident in the moſt perfect degree: in printing the word GOD, can the animal have the ſame ideas that this word produces in the head of the printer? Brutes neither have, nor can have, any other than *particular* or purely *ſenſible* ideas. It is impoſſible for them to riſe to our *univerſal* ideas; the reaſon is, because

cauſe they have not the gift of *ſpeech*. They do not generalize their ideas; they form no *intellectual* abſtractions. The *ſubject* is confounded by them with its *attributes*, or rather, with reſpect to them, there is neither *ſubject* nor *attributes*. Beings are only known to them by ſome ſenſible qualities. All their compariſons, all their judgments reſt immediately on theſe qualities. Brutes do not reaſon, to ſpeak exactly: they have not our *mean* ideas, becauſe they have not our *ſigns*. When therefore they appear to reaſon, they only compare or call to mind certain ſenſible ideas, from whence reſults ſuch or ſuch a motion, or ſuch or ſuch an action. The more in number and variety the ideas which are compared or recollected are, the more brutes ſeem to reaſon. This however never amounts to more than an appearance, which cannot deceive ſuch as ſhall have philoſophy enough in their minds to analyſe this motion or action, and aſcend to the principle. Grant to *beavers* the uſe of *ſpeech*: do you think they would eternally adhere to their rough architecture? Being then endued with the faculty of generalizing their models, they would diverſify their performances as much as their organs would permit them. Their attention diſplaying itſelf with freſh force, would cauſe them to diſcover things that eſcape the preſent reach of their knowledge. Theſe diſcoveries would lead to others, thoſe to others ſtill, and at the end of a certain number of generations, beavers would be on a level with our architects. But this is not a proper place for fathoming this metaphyſical ſubject, and ſhewing to what extent ſpeech perfects all our faculties. It is ſufficient for us to have pointed out the principal ſource of thoſe miſtakes that are ſo generally committed concerning the operations of brutes. The miſtake is much greater ſtill, when we aſcribe to them

them all our views and all our foreſight. I will not however deny that there are ſome facts of this claſs that aſtoniſh us, that ſeize violently on our admiration, and that would be capable of ſeducing the philoſopher himſelf, were he not continually on his guard. I have already recounted ſeveral of them; and ſhall now proceed to mention ſome others, that will not ſurpriſe us leſs than the former, and which, ſhould I omit them, would render my work ſo far defective.

CHAP. XXIX.

The caterpillar that conſtructs his cone in a fiſhing-net.

IN the fourth chapter of this part, we formed an idea of the conſtruction of the cones of caterpillars, and of the moſt remarkable varieties of this conſtruction in different ſpecies. We are far from having exhauſted this agreeable ſubject; we cannot even preſume to undertake to do it; but we may reſume it with pleaſure. A great caterpillar, that is eaſily known by its knobs or *tubercles*, which reſemble little *turquoiſes*, whoſe rings are ornamented, forms a large cone of pure ſilk, which is very gloſſy and extremely thick. This cone might enrich our manufactures, if we knew how to extract any part of it. Examine attentively that I have incloſed within this box. One of its extremities is round, the other terminates in a point. Look narrowly at this. It is open. How can an inſect, in his ſtate of inaction, be ſcreened from the inſults of little voracious animals, whilſt he remains in a ſhell open to all comers? He is ordained to ſpend there commonly nine or ten months, and it ſometimes happens, from particular circumſtances, unknown to us, that he continues in it for ſeveral

years. You begin already to tax the caterpillar with negligence, and to inquire why it did not take the precaution to ſhut its cone cloſe, like the ſilk-worm, and many other caterpillars? Suſpend your reproaches a moment: the butterfly into which this caterpillar transforms itſelf, has no inſtrument wherewith he can break or cut the thread of the cone, and clear himſelf a paſſage through it. He would then in ſuch a caſe remain a priſoner during his whole life-time in the cone, which you are deſirous of being ſo cloſed. The caterpillar then leaves it open: but it knows at the ſame time how to prevent the entrance of every voracious inſect into it. It makes a kind of fiſhing-net. The threads that compoſe it are much ſtronger than thoſe of the reſt of the cone. They are ſtiff; and as it were *gimped* or fringed. They are all of them diſpoſed and directed in the ſame manner, and terminate at the opening. The net or funnel that they form by their uniting together, has its mouth turned towards the inner ſide of the cone. Let us open this cone with ſciſſars: you ſee diſtinctly the whole contrivance of the little net. Your reproaches are now changed into commendations, and you admire the ſkill of the caterpillar. The net preſents itſelf to the caterpillar that is diſpoſed to iſſue from it, as our nets do to the fiſh that are inclined to enter them: conſequently, it is in the ſame poſition with reſpect to voracious animals, as our nets are to fiſhes that would eſcape from them.

I have not yet diſcloſed to you the whole art of the caterpillar. A ſingle net would certainly be hardly ſufficient: there are ſome inſects that might introduce themſelves into it, and devour the chryſalis. Our caterpillar therefore forms a ſecond net beneath or within the firſt, and the cords of this ſecond net are ſtill more compact than thoſe of the outer one.

Obſerve,

Obſerve, I pray, with what exactneſs the two nets are ſet in each other: you cry out, who would not acknowledge herein a determined end! Do not miſtake: the caterpillar has not propoſed to itſelf this end; but the AUTHOR of the caterpillar. Analyſe in a ſmall meaſure all the knowledge and reaſonings that this end might ſuppoſe in the caterpillar, and you will ſoon be able to diſcover that it is only a blind inſtrument that performs mechanically a labour that is neceſſary for the preſervation of the individual. This inſtrument may be diſordered in its operations, as any other machine may be: it may even be more diſcompoſed, becauſe it is leſs ſimple, and not a mere machine. Thus have we ſeen the cone of a caterpillar of this ſpecies that was quite round, very cloſe in every part, without nets, and from which there iſſues no butterfly. The like irregularities are obſervable in the labour of divers inſects, and particularly in that of bees. Theſe are probably not owing to *miſtakes* in the animal, as is commonly thought. Miſtakes ſuppoſe a poſſibility of choice, and, philoſophically ſpeaking, do animals chooſe? Is it not more likely, that the exerciſe of the organs, by being more or leſs diſturbed or modified by particular circumſtances, may produce theſe irregularities, which are often interpreted in a manner too much in favour of the free-will of the inſect? It is true, that real advantages ſometimes reſult from theſe irregularities, which the inſect improves, but has neither foreſeen or ſought theſe advantages: they were exceptions of one phyſical ſyſtem connected with others by the AUTHOR of the univerſal chain, who ſaw from all eternity the deviations of the caterpillar or bee, as he has thoſe of the heavenly bodies.

CHAP. XXX.

The rolling caterpillar, that conſtructs its cone like a grain of corn.

WE have greatly admired the ingenious and almoſt intelligent mechaniſm, by means of which divers caterpillars roll up the leaves of trees *. We ſtopped ſome time to conſider their different operations, as well when they gave to the leaf the form of a tube, as when they cauſed it to aſſume that of a coffin, fixed on its baſe as on a pyramid. You ſee theſe aſh-leaves that are thus rolled up like a coffin. They are inhabited by a little caterpillar, that has formed for itſelf therein a cone of pure ſilk, pretty nearly reſembling a grain of corn. We cannot examine this cone without opening the coffin. Let us do it with caution. The cone is lodged in the centre. You perceive little gutters on the exterior part of it; theſe are not what merit your attention moſt. Obſerve particularly in what manner this little cone is ſuſpended in the middle of the coffin, by the help of a thread or a little ſilken axis, one of whoſe extremities is fixed to the top of the cone, and the other to its baſe, or the flat part of the leaf. Look narrowly at the place where the thread joins to the flat part of the leaf: you will perceive a ſmall piece in it exactly circular, bored in the thick part of the leaf, and that ſeems to conceal ſome ſecret deſign. This you will find in many coffins; but it often happens that you will ſee in that place a little round hole, well turned, that appears to have been made by a *gimblet*. The circular piece is the work of the ca-

* Chap. 7. of this part.

terpillar;

terpillar: it has ſkilfully gnawn that part of the leaf; and has cut a little piece of it in a circular form, which it has been very careful to leave in its place. You ſeem to diſcern the end of this labour. It is contrived for a private paſſage for the caterpillar to go out at, at the ſame time that it prevents the entrance of any miſchievous inſects into the coffin. Our induſtrious caterpillar then makes a little door into its cell. This door is not to be opened till after the laſt metamorphoſis. The winding parts of it being interwoven with the leaf, it remains as it were ſubſervient to it. In iſſuing from the cone, the caterpillar deſcends by the whole length of the thread, which holds it ſuſpended; it follows the direction of it, arrives at the door, and burſts it open by puſhing its head againſt it. Theſe coffins, which you ſee pierced through, have been abandoned by the caterpillars.

CHAP. XXXI.

Analogous proceedings of other inſects.

OUR grain is liable to be eaten by a very ſmall inſect, that lodges within it, and is there metamorphoſed. The covering of corn is a kind of very cloſe box, which the caterpillar lines with ſilk. But the caterpillar is provided with no inſtrument to pierce through this box, and would remain priſoner therein, if the inſect were not inſtructed how to prepare a paſſage from it. It proceeds in the ſame manner as the roller of the aſh; it cuts with its teeth a little round place in the covering of the grain, which it is very careful not to diſengage entirely from it. The butterfly need only preſs againſt this part, in order to obtain its liberty.

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In the centre of the *capper* thiſtle there is a large oblong cavity, which is commonly inhabited by a ſmall caterpillar, that makes a ſort of cone therein, where ſhe transforms herſelf. The rind of the thiſtle is much harder than that of our corn. It would be impoſſible for the butterfly to force a paſſage through it. It would have occaſion for very ſtrong teeth for that purpoſe, and is furniſhed with no ſimilar or analogous inſtruments. The caterpillar, which ſeems ſenſible of this, makes a ſkilful proviſion for the neceſſities of the butterfly. It pierces in different parts the walls of its lodge, and makes a ſmall round hole in it, oppoſite the extreme part of the cone which the butterfly is to go out at. But, were this hole to remain open, the chryſalis would be too much expoſed. The caterpillar contrives a very ſimple expedient for ſtopping up the aperture. The whole exterior part of the head of the thiſtle is covered with the ſeeds of the plant. They are implanted in the rind, between the thorns. They are ſmall oblong, chanelled bodies, placed near each other. The caterpillar brings ſome of theſe little bodies to the outſide of the hole. They there perform the office of nets to the cone, of which I have ſpoken in the preceding chapter.

In treating of the proceedings of *aquatic* moths *, we have remarked that they transform themſelves in their caſe. There muſt be a continual freſh ſupply of water in this incloſure. No voracious inſect ſhould be allowed acceſs to it. Inſtead of placing a full made door at the entrance of its lodge, the moth puts a grated one there, which grate-work anſwers every end. Let us not attribute our method of reaſoning to this moth. Does ſhe know

* Chap. 11. of this part.

that

that voracious inſects have a deſign againſt her life? Is ſhe ſenſible that ſhe will inveſt a form under which ſhe will not be able to fly? No; ſhe is ignorant of all this; nor does it concern her to know it. She has been taught to ſpread threads that are capable of growth; ſhe does ſpread them, in ſo doing, ſhe ſatisfies a want that is purely phyſical, and provides by a machine againſt the inconveniencies which ſhe neither knows or can know. Judge on the ſame principle of other facts of this kind. It is always the AUTHOR of the inſect who alone is to be eſteemed wonderful.

CHAP. XXXII.

The leaf-moth.

WE promiſed to return to the *field*-moths *: this is the place for that purpoſe. Their proceedings are ſo ſingular, and in appearance ſo full of reflection; and the inſect can vary them ſo effectually, that they require us to enter into a detail of them, and that we endeavour to form philoſophical ideas concerning them.

Our moth cloaths itſelf, as we have ſeen †, with the membranes of leaves. The form of its incloſure is curious. It borders on the cylindrical: but the ends are differently ſhaped. The fore-part, or that which ſhews the head of the moth, is rounded, projecting, and bordered. The hind-part conſiſts of three triangular pieces, which their natural ſpringineſs tends to unite by their extremities, and that can ſpread from each other to admit the egreſs of the poſterior part of the inſect. Sometimes the caſe or incloſure is adorned with a denting on the back, reſembling the fins or *pinnæ* of carp.

* Chap. 11. of this part. † Ibid.

In order to conſtruct this caſe, the moth creeps into the thick part of a green leaf; inſinuating herſelf between the two membranes that compoſe it. She removes from it the *pulp* or parenchymia which incloſes it. This pulp is the nouriſhment appropriated to the moth; ſo that at the ſame time ſhe ſatisfies the neceſſities of hunger, ſhe prepares the ſtuff her dreſs is to conſiſt of. The two membranes are this ſtuff. Each of them is of the ſame uſe to the moth as a piece of cloth to a taylor. Like the latter, ſhe gives the various parts of the ſuit thoſe windings and proportions which they ſeverally require, in order to anſwer the uſe they are deſigned for. The cloaths the moth intends to make, are formed of two ſimilar and even pieces of leaf, joined together on the back and belly. She then cuts out of each of the membranes betwixt which ſhe is placed, a piece of ſuch a ſhape and ſize as will make one half of the ſuit. Our moth executes with as great juſtneſs and exactneſs as if ſhe had a pattern to guide her.

The dreſs being cut out, ſhe next proceeds to make it up. The moth at firſt collects together all the pieces in a pretty rude manner, ſhe only *baſtes* them, if we may be allowed the expreſſion, before ſhe joins them more cloſely together; ſhe is willing to be aſſured of their juſtneſs, to try them, and cauſe them to *ſit well* on her own body. Thus by turning round in it, and putting herſelf into as many poſitions as will be afterwards neceſſary, ſhe moves them to a proper diſtance from each other, and by planing renders them convex. She then ſews them up cloſer; and makes it ſo well, and with ſuch propriety, that it is difficult to diſtinguiſh the parts where the two edges had been adjuſted to each other.

I paſs

I paſs over with regret many leſſer particulars, that would greatly advance the wonderful art of our little workman. I have not even taken ſufficient notice of the various winding ſhapes of each piece. They are almoſt ſo in the ſame degree as thoſe in our cloaths. I have touched but lightly on the manner in which the moth prepares the ſtuff, poliſhes, thins it, and diſcharges it of all the parenchymia, making it as ſupple as it is light. All theſe articles belong to a particular hiſtory of moths: my deſign is here to give only the more ſtriking parts of this hiſtory.

Laſtly, the moth does not content herſelf with a bare incloſure of leaf: this would probably be neither ſoft nor warm enough. She lines it with pure ſilk, and is careful to make the lining of a thicker contexture in thoſe places where the friction is greateſt.

After having put the laſt hand to her dreſs, ſhe ſets herſelf to work to diſengage it from thoſe parts of the leaf in which it was as it were caſed up. To effect this, ſhe requires leſs ſkill than ſtrength. She thruſts her head out of the incloſure; bears it forward: faſtens herſelf to the leaf by her fore-legs, ſtrives to advance in a ſtreight direction, and at the ſame time takes faſt hold of the inſide of the incloſure with her hind-legs, &c.

The moth we have juſt now obſerved to dreſs herſelf, cuts out her cloathing from the middle of the leaf, but ſhe often takes it from the edges. In that caſe ſhe need only cut the membranes on one ſide, to wit, on that which is oppoſite to the jagged parts; for near the border of the leaf theſe membranes are united by nature much better than they could be by the induſtry of the inſect. They are more curved than the form of the incloſure requires. The labour of the moth is then applied

to clear the dentings, and to remove the pulp from it, which would load the incloſure too much, or by drying it up would alter the conſtruction of it.

Whilſt ſhe is employed about this, let us cut away the jagged parts with a pair of ſciſſars: what will the moth do in this caſe? will ſhe proceed in ſhaping the pieces intended to form her dreſs? we have lately cut thoſe on the indented ſide; it now remains to cut the oppoſite ones; but remark that they are joined to the leaf by this ſide only: ſo that if the moth were to cut them in this place, they would then have no ſupport, would ſeparate from each other, and it would be impoſſible for her to re-unite them, and give them their proper fold. Again, what meaſures would the moth take in this difficult circumſtance? what method would ſhe purſue to repair the diſorder we had occaſioned in her work? how would ſhe extricate herſelf from a ſituation ſo ſtrange and unforeſeen?

Inſects have accuſtomed you to attribute great things to the reſources of their genius, and you are in full expectation that our moth will find means to return to her work, and contrive ſome expedient that you are not aware of, which will repair the whole. In effect, ſhe immediately renounces her firſt project, abandons her uſual procedure; and changes her method, purely becauſe it is abſolutely neceſſary ſo to do. Inſtead of applying herſelf to cut out the parts of her dreſs, ſhe endeavours to join again with ſilk threads the two membranes the ſciſſars had ſeparated. She afterwards lines them before ſhe cuts them. Theſe membranes, which were at firſt very tranſparent, are now ſeen to become more and more opake, and to change their colour. We plainly perceive that this opakeneſs and alteration of their tincture are owing to the ſilk lining uſually given by the moth to her incloſure.

cloſure. As ſhe lines the membranes, ſhe renders them more convex: ſhe endeavours to make them repreſent a cylindrical tube, which they already pretty nearly do. Little more now remains than to cut them on that ſide where they join to the leaf. But how will the moth be able to effect it in this place? The lining is properly a ſheath of ſilk: Does not the moth, by incloſing herſelf in this ſheath, cut off all communication with the membranes they cover? Will ſhe then think of cutting through the lining with her teeth, in order to make way for herſelf acroſs it? By no means; ſhe had the precaution to contrive apart ſeveral openings at various diſtances; ſhe left here and there void ſpaces in the cloth: ſhe thruſts her head through theſe openings, and ſhapes the membranes to her liking, collects them together, unites them in a compact manner, and concludes with ſupplying all the vacant ſpaces in the lining.

This indeed, I think, is abundantly ſufficient to impreſs on us an high idea of the induſtry of our moth. I have not however yet made an end of offering all that is admirable with reſpect to their ſagacity. You recollect that the extremities of the incloſure are differently ſhaped: the fore-part is round, bordered, and juts out a little: the hind-part conſiſts of three triangular pieces, which are kept near each other by their natural ſpringineſs. If we had left this moth to herſelf, and had not diſturbed her in her work, ſhe would have cut out the fore-end of the incloſure from that part of the leaf neareſt the pedicle; the poſterior would then have been taken from the oppoſite one. But the abridgment we made of the dented parts occaſioned ſuch a diſorder, as did not permit the moth to purſue her original plan. We have taken off from the leaf thoſe contours and proportions which ſerved

her to reckon by, and enabled her to determine the place and form of the extremities of the incloſure. She follows therefore the reverſe of her ordinary method: and ſets about cutting the fore-end of the ſide joining to the point of the leaf, and the hind part of that which is neareſt the pedicle.

Had our moth been a mere machine, we ſhould not have been able ſufficiently to comprehend, how ſhe could vary her operations as neceſſity required. Let us not however conclude that there is nothing of the naure of a machine in all this, nor attribute to intelligence what is only the produce of certain ſenſations, and of the ſtructure of the body. After all, the greateſt and moſt embarraſſing wonder in this reſpect is, the change produced in the moth's method of working. When ſhe takes her cloathing near the edge of a leaf, ſhe has only the membranes of one ſide to cut. This ſide is that intended to cover the belly of the inſect. The oppoſite ſide is already intirely faſhioned by the hands of nature; it comprehends every thing the moth deſires relative to the windings and union of the membranes. The back of the incloſure will then retain the dented parts of the leaf, and the moth hath nothing more to do than to clear them thoroughly from it. If whilſt ſhe is buſy in doing this, we ſhould cut off the dented or notched parts with a pair of ſciſſars, the two membranes which nature had cloſely united would by that means be ſeparated, and the air have a free acceſs into the mine. But every moth is uneaſy under the immediate contact of the air: they all ſeem, in preparing their dreſs, to ſhelter themſelves from it. Our moth, being too much expoſed, would preſently fall to work to cover herſelf. She would ſpread threads from one membrane to another. She has moreover the ſilky matter to evacuate which the food continually produces:

duces: having lately devoured the pulp incloſed in the notched parts, this aliment is converted into ſilk. Her neceſſity for ſpinning goes hand in hand with the diſagreeable ſenſation occaſioned by the contact of the air. The moth is not determined by reflections ſhe is abſolutely incapable of: ſhe does not refrain from cutting the membranes becauſe ſhe judges they would fail her for want of a prop. This judgment would ſuppoſe ſuch knowledge, compariſons, and concluſions as are very evidently above the reach of inſtinct. If you take the trouble to examine thoroughly into this, I will venture to affirm, that you will aſſent to my opinion. Our moth then does not ſet about cutting the membranes till ſhe has joined them on that ſide where they had been ſeparated. She has lined theſe membranes with ſilk, has furniſhed the whole inſide of the mine, and we are deſirous to know how it could happen that this lining did not prove an obſtacle to her when ſhe applied herſelf to cut the membranes? We have remarked, that ſhe left here and there void ſpaces in the lining, to admit her head to paſs through, and we have greatly admired this kind of prudence. An illuſtrious obſerver has certainly too much exalted it, as he has likewiſe other procedures of this induſtrious inſect: he has almoſt granted to it a degree of that underſtanding which appears ſo conſpicuous in his learned inquiries. Are not theſe ſpaces, which appear to be ſo artfully contrived in the lining, the mere ſimple effect of the want of ſilk? The moth muſt neceſſarily have been greatly exhauſted by uniting and lining the membranes: it is not then to be wondered at that the lining was not continued throughout: it is not in effect, and we take a pleaſure in doing honour to the prudence of the moth.

We

We do not know, whether by this change in her method of working the anterior extremity of the incloſure does not always take place of the poſterior, and ſo reciprocally; but the inverſion in queſtion would only prove, that by retrenching the indentions, we had deſtroyed, at one of the extremities of the leaf, thoſe contours or windings which the faſhion of the fore-part of the dreſs requires. The oppoſite extremity of the mine apparently affords more favourable conditions to this part of the work, and it is very natural that they ſhould determine the moth to place there the anterior aperture of her incloſure, &c.

Although the moth might ſave ſome labour in giving thoſe notches to the ſhape of her dreſs, it nevertheleſs often happens, that ſhe rather chooſes to cut them from an intire leaf. If we obſerve attentively, we ſhall perceive, that ſhe takes this method when the edges of the leaf begin to dry. There are certain circumſtances in the order of her ſenſations which influence her performances. Nor do certain operations, which aſtoniſh us, reſult leſs from the order of mechaniſm in her organs, as from their immediate principle.

Too much has been attributed to the ſhape of the dreſs; it has been repreſented as more curious than it is in reality. It is however at moſt that of a nearly cylindrical tube, whoſe form and dimenſions the extended body of the inſect can determine mechanically, without any neceſſity for our admitting here the leaſt ſhadow of intellectual knowledge. It is true the extremities of theſe tubes are differently ſhaped; but the parts of the leaf in which they are cut, muſt influence more or leſs the faſhion of each of them, &c.

CHAP.

CHAP. XXXIII.

Reflections on the induſtry of animals.

I Have only pointed out the ſources whence I would derive the ſolution of all thoſe little problems which the labour of the *leaf-moth* preſents us with. I would deduce from analogous ſources the ſolution of the many problems which the induſtry of thoſe animals that ſtrike us moſt affords us. I would not ſuppoſe, that they propoſe to themſelves an *end*, like us, in their various operations: the ideas of *end*, *deſign*, and *means*, are too reflective to enter the head of an animal that cannot have *notions* properly ſo called, and that is reduced to mere *ſenſations*. It is ſo natural for us to *reflect*, becauſe it is ſo natural for us to *connect* our ideas to *ſigns*, and from thence to form *notions* of every kind, that we preſently imagine the animal is alſo capable of *reflecting*. We cauſe it then to act exactly from the ſame motives as determine us in the like caſe. Are we to account for ſome remarkable proceeding in which we imagine we diſcover ingenious views? We immediately ſuppoſe ſuch views; we join to them little implicit reaſonings, and all explains itſelf as happily as poſſible; but this muſt be done, as I have ſaid elſewhere, by inadvertently transforming the animal into man, and pure ſenſations into real notions. If the animal could, without ceaſing to be an animal, judge of our operations, there is reaſon to believe that it would not afford us the proper motives for determining us. It would cauſe us to act as it acts itſelf: it would transform us into mere animals.

I need not then endeavour, from the end which we diſcover in the work of an induſtrious animal, to

to find a reaſon for this work. I would not ſay, *The ſpider ſpreads a net to catch the flies*; but that *the ſpider catches the flies becauſe ſhe ſpreads a net*, &c. and ſhe forms a net, becauſe ſhe has *occaſion to ſpin*. The end is not leſs certain, or leſs evident; only, it is not the animal that has propoſed it, but the AUTHOR of the animal. What loſs would natural theology ſuſtain by this method of reaſoning? would it not, on the contrary, acquire a greater degree of exactneſs and preciſion? Let us reaſon then on the operations of animals as we do on their ſtructure. The ſame WISDOM which has conſtructed and arranged with ſo much art their various organs, and has cauſed them to concur to one determinate end, has likewiſe cauſed thoſe numerous operations, which are the natural effects of the œconomy of the animal, to contribute to one end. He is directed towards his end by an inviſible HAND; he executes with preciſion, from the very beginning, the works which we admire; he ſeems to act as if he was capable of reaſoning, to turn about with propriety, and to change his method as there is occaſion, and in all this only obeys thoſe ſecret ſprings by which he is actuated; he is only a blind inſtrument that cannot judge of his own action, but is excited to it by that ADORABLE MIND which has traced out to every inſect his little circle, as he has marked out to each planet its proper orbit. When therefore I ſee an inſect working on the conſtruction of a neſt, a cone, or a chryſalis, I am ſeized with reſpect, becauſe I am beholding a ſight where the SUPREME ARTIST is concealed behind the ſcene.

Animals that have a greater number of *ſenſes*, have likewiſe a proportionable number and variety of ſenſations. And as they diſtinguiſh them, ſo they compare them after their manner. From hence proceed

proceed thoſe judgments which ſeem allied to *reflection*, but are nevertheleſs only the ſimple conſequences of the compariſon of certain ideas which are purely *ſenſible*.

I have yet ſome ſtriking particulars to relate concerning the induſtry of animals. I ſhall not again arm my reader before-hand againſt the ſeductions of ſurpriſe and admiration: I have already ſaid enough on that head to prevent his being miſled by them *. I have enabled him to render into philoſophical language, thoſe expreſſions which may have been deficient in point of exactneſs, and have heretofore or may hereafter ſlip from me. It is allowable to deviate a little from philoſophical rigour, and to grant ſomething to the intereſt of the narration, when we apply ourſelves to fix the ſenſe of words, and to give, if we may ſo ſpeak, the key of the diſcourſe.

CHAP. XXXIV.

The bee that conſtructs a neſt with a ſort of glue.

IN treating with rapidity of the various proceedings of inſects, relative to the manner in which they depoſit their eggs. I ſpoke of a very curious neſt which a ſolitary bee formed with pieces of leaves †. I repreſented it to be compoſed of a ſeries of cells, and joined together as thimbles are for ſale in a ſhop. I deſcribed the prodigious art diſplayed in the conſtruction of this neſt, each cell of which is formed of ſeveral fragments of leaves, cut, rolled, and collected with equal exactneſs and propriety, and as capable as a cloſed veſſel of con-

* Conſult chapters 19. 25. and 27. of part ix. chap. 29 of this part. † Part xi. chap. 5.

taining

taining liquor without danger of its ever running out. Laſtly, I ſet forth, that this aſſemblage of cells, ſo regularly and ſkilfully cut out, is covered over with one general foldage, of the ſame matter with the cells, and reſembling the form of an inſtrument-caſe.

This neſt, which I have now given an idea of, is hid under ground. The bee there digs a cavity proportioned to the ſize of the caſe. We are alſo to ſeek under the earth for the neſt of another ſolitary bee, whoſe induſtry is little inferior to that of the leaf-*cutter*, and that works almoſt on the ſame plan. Its neſt is likewiſe compoſed of ſeveral cells, artfully let into each other; but are not covered with a common incloſure. Each cell conſiſts of two or three membranes, placed on one another, and are inexpreſſibly fine. Examine with the microſcope, they preſent you with nothing that may give room to ſuſpect they were not taken from plants. One would imagine them to be of a pure ſilky nature, and of the fineſt white. But the bee does not ſpin: what then muſt the matter of theſe membranes conſiſt of, which appear ſo fine, ſo gloſſy, and white? By obſerving attentively the cavity in which the neſt is incloſed, we ſhall find it ſmeared with a ſlight layer of gloſſy matter, exactly ſimilar to that of the cells, and may be compared to that viſcous humour which ſnails ſpread in their paſſage. A bee has undoubtedly an ample proviſion of this kind of glue, which ſhe employs with ſo much art: but as ſhe works underground, and in profound obſcurity, we have not yet been able to ſurpriſe her at her labour. Notwithſtanding the extreme delicacy of their membranes, the cells have a ſufficient degree of conſiſtence, and may be handled without altering their form. The *paſte* contained in them ſupports their walls, and

and prevents their giving way. This paſte is a kind of wax, moderately tempered, and ſometimes not at all. An egg is depoſited at the bottom of each cell. After it is hatched, the worm finds itſelf in the midſt of a plentiful ſtock of proviſions. It acts with a kind of intelligence in the manner of conſuming, and ſeems to conduct itſelf as though it would preſerve a neceſſary prop to the walls of the apartment: it does not dig into the paſte in all parts, but ſcoops it perpendicularly from the bottom to the top: it forms by this means a little ſtalk, which occupies the axis or center of it. As it increaſes in growth, it enlarges this ſtalk, extending it in length and width. At length it arrives at the walls; and has then conſumed all the paſte, and completed its growth.

CHAP. XXXV.

The tapeſtry-bee.

MANY ſpecies of ſolitary bees content themſelves with penetrating into the earth; ſcoop out cylindrical cavities therein, and poliſh the walls. They depoſit an egg there and amaſs a ſufficient quantity of nouriſhment.

There is another ſpecies of theſe worms that pierce the earth, whoſe induſtry is much more remarkable. They do not content themſelves, like the others, with an intire naked cavity. On viſiting the inſide of the lodge, immediately after its conſtruction, we are agreeably ſurprized to ſee it hung quite round with tapeſtry of the moſt beautiful crimſon ſattin, affixed to the ſides as our tapeſtry is to the walls of our apartments, but with much more propriety. The bee does not only line in this manner the whole inſide of her dwelling; but alſo

ſpreads

ſpreads the ſame kind of tapeſtry round the entrance to the diſtance of two or three lines. We have obſerved many caterpillars that line the inſide of their cone or incloſure with ſilk *: our bee is the only inſect at preſent known, which, properly ſpeaking, hangs her neſt with tapeſtry, as we do our apartments. It is therefore with good reaſon that this induſtrious animal has received the name of the tapeſtry-bee.

You are impatient to know from whence ſhe procures the rich tapeſtry. Look at the flowers of this wild-poppy, which are newly blown: obſerve that they are ſloped here and there. Compare them with the tapeſtry whoſe tiſſue you are deſirous of knowing, you can find no difference between them: this tapeſtry is no other than the fragments of the flowers of the wild-poppy; and that is the ſecret origin of thoſe ſlopings you remark on the poppies that border upon the neſt. Your curioſity is not yet ſatisfied; you are deſirous of obſerving a little the labour of our ſkilful worker in tapeſtry.

The hole, which ſhe digs perpendicularly into the earth, is about three inches in depth. It is exactly cylindrical, as far as to ſeven or eight lines of the bottom. There it begins to open wider, which it does more and more. When the bee has made an end of giving it the ſuitable proportions, ſhe proceeds to line it with the tapeſtry.

With this view, ſhe applies herſelf to cutting, with abundance of art, pieces of petals † of an oval form from the flowers of the wild-poppy, which ſhe ſeizes with her legs, and conveys into her hole. Theſe little ſcraps of tapeſtry, when tranſported thither, are very much crumbled; but the *tapeſtry-*

* Chap. 4. & ſeq. of this part.

† This is the name given by botaniſts to the leaves of flowers.

bee

bee knows how to ſpread them out, diſplay them, and affix them to the walls with aſtoniſhing art.

She applies at leaſt two layers of the petals. She ſpreads two tapeſtries on each other. The reaſon of her furniſhing herſelf with it from the flowers of the wild-poppy rather than from thoſe of many other plants, is, becauſe in them are united to a higher degree all thoſe qualities which are requiſite for the uſe to which the bee deſigns to put them.

When the pieces which the bee has cut and tranſported are found to be too large for the place they are intended to occupy, ſhe cuts off the ſuperfluous parts of them, and conveys the *ſhreds* out of the apartment

After hanging the tapeſtry, the bee fills the neſt with *paſte*, to the height of ſeven or eight lines. This is all that is neceſſary for the nouriſhment of the worm. The tapeſtry is deſigned to prevent the mixture of particles of earth with the paſte.

You expect undoubtedly that the prudent bee ſhould not fail to cloſe up effectually the aperture of the neſt in order to hinder the acceſs of thoſe inſects into it that are fond of the paſte: this ſhe takes proper care to do: and it is utterly impoſſible for you to diſcover, from the ſurface of the ground, the ſpot where the neſt was, whoſe conſtruction you have juſt been contemplating, ſuch is the ſkill employed by the bee in cloſing it. This little white pebble was at the edge of the hole, or very near it; it has not changed its place, and indicates to us the part beneath which the neſt is we are ſearching for. It ſeems then as if we ſhould have nothing more to do than to raiſe up a light layer of earth, in order to expoſe to view the entrance of the hole which has been ſo well cloſed. Nothing can be eaſier or leſs doubtful. How great is your ſurpriſe! you have already taken up two or three inches

inches of the earth in depth, and you cannot find the leaſt appearance either of the hole or the tapeſtry. What can this mean? What is become of the neſt that was ſo ſkilfully conſtructed, ſo properly lined, and was upwards of three inches deep? A few hours ſince, you admired the ingenious contrivance of it, and now the whole has diſappeared, ſo that you cannot diſcover the leaſt trace of it. What myſtery then is this? It is effected as follows:

When the bee has done laying, and amaſſed her quantity of paſte, ſhe takes down the tapeſtry, folds it over the paſte, which ſhe wraps together in it pretty nearly as we fold on itſelf a coffin of paper that is half full. The egg and paſte are by this means incloſed within a little bag of flowers. The bee has then nothing farther to do, but to fill up with earth all the void ſpace that is above the bag; and this ſhe performs with ſuch wonderful activity and exactneſs, as utterly to conceal the place where the neſt was.

CHAP. XXXVII.

The maſon waſp.

WE muſt not confound this inſect with the *maſon* bee I before treated of *. Their labour is as different as their form. The waſp I am about to deſcribe has received the name of *ichneumon*, from its reſemblance to *ichneumon* flies, that depoſit their eggs in the bodies of living inſects †. She lives a ſolitary life; and tho' there be in her proceedings nothing that is common to thoſe of the *republican* waſps ‡, they are but little behind them in point of

* Part xi. chap. 5.
† See the note of chap. 5. part xi.
‡ Part xi. chap. 23.

induſtry. It cannot therefore be diſagreeable, that I here relate ſome particulars concerning them.

Our *ichneumon* waſp digs in the hard ſand a hole of about the depth of two inches. Her labour is not confined to the making this hole, giving it a cylindrical form, poliſhing the walls of it, and carrying out of it the excavated ſand: ſhe forms a pillar of this ſand, which has for its baſis the opening of the hole, and is raiſed up nearly to a height equal to the depth of the latter. This ſeems to be an important work, that is intended to remain. It is formed with great art, in the manner of filigree work.

The waſp works in a very hard ſand, which the nail can ſcarcely penetrate. Altho' ſhe is provided with very good teeth, ſhe does not make uſe of them for piercing the ſand, or forcibly detaching the grains of them from it: ſhe has a much more eaſy and ſimple method of accompliſhing it. She can ſoften it, reduce it to a ſupple paſte, that may be moulded as ſhe pleaſes. She communicates to it a penetrating liquor, with which ſhe is well provided.

She kneads with her teeth and fore-feet the molecules ſhe has mollified and ſeparated. Of this ſhe forms a ſmall pellet or ball, that is a little extended in length. She places this firſt pellet on the border of the hole ſhe has begun to dig, and thus lays the firſt foundation of the pillar ſhe propoſes to erect. The whole of it is compoſed of ſuch balls as theſe, ranged circularly on the ſide of and over each other. In placing freſh pellets, the waſp ſpreads them a little with her teeth and feet.

She frequently ſtops in the courſe of her work; this doubtleſs is occaſioned by the tempering liquor being pretty ſoon exhauſted. She quits her workſhop, flies away, and returns in a few minutes afterwards

wards to reſume her labour. This was done in order to provide a freſh ſupply of liquor.

The work is carried on with great diſpatch, and with greater ſpeed than one would imagine. In a few hours ſhe will have dug a hole of the depth of two or three inches, and have raiſed up in it a pillar of nearly the ſame degree of elevation.

She conſtructs ſucceſſively ſeveral of theſe neſts, all of which have the ſame eſſential form, and the ſame end.

After the pillar is raiſed perpendicularly above the hole, it becomes a little curved, which is afterwards increaſed more and more, preſerving always its cylindrical form.

The inſect does not conſtantly proportion the elevation of the pillar to the depth of the hole: it is ſometimes leſs elevated than that is deep. This is not for want of the balls: ſhe is ſeen to be continually kneading them, but inſtead of placing them, ſhe throws them from the pillar.

You naturally imagine that the hole which the *maſon* waſp digs in a perpendicular direction in the ſand, is a neſt deſtined to receive an egg. But you cannot conceive the uſe of the little edifice in filigree-work that is built a-top, and that implies much more labour and induſtry than the bare operation of ſcooping out the earth.

The ſubſequent part of the performances of our laborious animal will inform you, that this pillar, which is made with ſo much ſkill, is only a kind of ſcaffolding, that is not intended to ſubſiſt. The balls which compoſe it are of the ſame ſervice to the waſp as a collection of materials or ſhards are to a maſon. Our maſon has diſpoſed them accordingly in ſuch a manner as to have them as much within her reach as poſſible. She makes uſe of them for ſtopping or filling up the hole after ſhe has depoſited an

an egg in it. ſhe then demoliſhes the little edifice, and ſoon afterwards there remains not the leaſt veſtige of it.

This kind of little tower has likewiſe another very important uſe, it prevents the enterprizes of *ichneumons*. It is well known that theſe inſects are apt continually to gnaw about the neſts of others in order to lay their eggs in them: this little tower renders the maſon's neſt more difficult of acceſs; they are not hardy enough to venture themſelves in ſuch a long and obſcure paſſage.

A worm is to be hatched from the egg which the maſon waſp has laid at the bottom of the hole. The neſt is ſtrongly walled: the worm can neither receive nor go out to ſeek for its food. The parent inſect has furniſhed it with proviſion. It lives at eaſe at the bottom of the hole. The dam has had the ſagacity to reſerve a ſpace of ſeven or eight lines, which ſhe has filled with proper nouriſhment. Any one who ſhould be unacquainted with the hiſtory of inſects would not be able to imagine of what nature theſe proviſions are; and the naturaliſt, to whom they are known, no leſs admires them. If we open the neſt carefully, we ſhall perceive, that the part which is not walled has been filled with little living worms, of a green colour, and without legs, artfully diſpoſed on one another, in a circular form. Theſe worms fill up the whole capacity of the little cavern. There are commonly reckoned to be ten or twelve in each neſt. This is exactly the quantity of proviſion neceſſary for the growth of the young of the waſp. As ſoon as it is hatched, it attacks the worm neareſt to it, pierces its belly, and ſucks it at pleaſure. It proceeds afterwards to that which is placed immediately above it, and when it has made an end of conſuming all the proviſion in this manner, it has attained its full

growth, and is on the point of transforming itſelf: the moſt ſkilful purveyor would not take better meaſures than our parent waſp does; ſhe received her inſtructions from HIM who provides for the neceſſities of all his creatures. The waſp knows which are the worms appropriated to the ſubſiſtence of her family. She goes in queſt of theſe worms, ſeizes them gently, and tranſports them to her neſt without wounding them. All ſuch as ſhe incloſes there are of the ſame ſpecies, and are of ſuch an age as to have acquired their full growth. Had ſhe made choice of ſuch as were younger, they would have periſhed for hunger in the cavern, would have afterwards corrupted, and in their turn have proved the death of the young. She therefore only ſelects from amongſt worms of the ſame ſpecies, ſuch as have arrived at an age in which they can endure a pretty long faſt. All of them, however, are not of the ſame ſize. When the waſp provides for her young with the larger ſort of worms, ſhe gives them a leſs number of them; and a greater number, when they are of the ſmalleſt ſize. One may ſay, that ſhe knows how to make amends for the ſize by the number, and ſo reciprocally.

CHAP. XXXVII.

The lion-piſmire.

NO inſect is more celebrated for its induſtry than this. Its name is connected in the mind to the idea of proceedings of a very ingenious nature, which we never fail to diſcourſe of to ſuch young people as we wiſh to inſpire with admiration at the wonders of nature. I know a naturaliſt who, before he was ſeventeen years of age, ſet out with doubting of theſe proceedings, and could find

no reſt till he had verified them: he did ſo, admired them, diſcovered new ones, and ſoon became the diſciple and friend of the PLINY of France *. By delineating in his works the diſcoveries of this illuſtrious perſon, he has ſtrew'd ſome flowers on his tomb, which are but faint expreſſions of his regret, and of the remembrance of one that will be ever dear to him.

Every body knows that the lion-piſmire digs for himſelf, in the dry ſand, or in a greatly pulverized earth, a pit like a mill-hopper or funnel, at the bottom of which he lies in ambuſh. As he walks only backward, he cannot purſue his prey; he therefore lays a ſnare for it, and particularly for the ant, on which he founds his hopes. It might have been more properly called the *fox-piſmire*, had not this name been too long eſtabliſhed.

He commonly remains concealed under the ſand; whether he lies ſtill at the bottom of his trench, or changes his place, he never expoſes any part but the end of his head. That is ſquare, flat, and armed with two little moveable horns, in the form of hooks or very fine pincers, the ſingular ſtructure of which aſtoniſhes the obſerver, and ſhews to what

* Mr. DE REAUMUR, who died in 1757, with whom the author carried on a literary correſpondence for the ſpace of twenty-nine years and upwards. He communicated all his diſcoveries, in the moſt copious manner to this excellent naturaliſt: but his letters, which would compile a large volume of obſervations, have been conveyed from the cabinet of this illuſtrious academic after his death. If the reiterated attempts the author has made for recovering them had proved more ſucceſsful, he would have reviſed them, ſo as to have rendered them worthy the attention of the public. Some celebrated naturaliſts have already anticipated him concerning ſeveral of theſe obſervations, which they have publiſhed, without having had any knowledge of what the author had diſcovered before them. This he does not in the leaſt regret, ſince the public could not have been better ſerved than they have been by thoſe able naturaliſts. The firſt of the author's obſervations were made in the year 1737.

degree nature is admirable even in her ſmalleſt productions. The anatomy of our lion-piſmire is not our preſent object, you are not ſo curious to know how he is made, as what he does. You know in general, that his form ſomewhat reſembles that of a palmer or wood-louſe, and that his body is carried on ſix legs, terminates in a point, and is compoſed of a ſucceſſion of rings which are purely membranous. This is all that is neceſſary for your information concerning his ſtructure: a longer detail would be ſuperfluous.

When he intends to hollow his trench, the piſmire begins by tracing out a circular furrow in the ſand, whoſe diameter equals the depth to which he deſigns to ſink it. There is always a certain relation between this opening, and the depth of the trench: the latter is commonly nine lines, when the former is twelve. In general, the ſize of the trenches varies very much: the largeſt are about two or three inches at the opening, and the ſmalleſt, two or three lines. It is not a rule with them, for the greateſt piſmires to dig the largeſt pits: one of a middling ſize is frequently found to lodge himſelf in a very large one; and a very great one in a pit of a middling ſize. This is owing to particular circumſtances, which it would be needleſs to mention.

After having determined the opening of his trench, or traced out the firſt furrow, the lion-piſmire opens a ſecond, concentrical with the former. You are to underſtand that the whole of his labour tends to the throwing out all the ſand contained in the compaſs of the firſt furrow. Imagine then to yourſelf a cone of ſand, whoſe diameter is equal to that of the circumference, and whoſe height is equal to the depth which the tunnel or trench ſhould have; this cone of ſand he applies himſelf to ſcoop out.

The

The inſect performs this with his head, as with a ſhovel. You have ſeen that it is ſquare and flat, a form very ſuitable to this office. He loads himſelf with ſand by means of one of his fore-feet, and when his head is fully loaded with it, he whirls the ſand briſkly out of the circle. This little operation is performed with ſurprizing ſwiftneſs and ſkill: a gardener does not proceed with ſo much diſpatch, by the help of his ſpade and foot, as our piſmire does with his head and leg.

It is hardly neceſſary to inform you, that the reſt of the workmanſhip of our inſect is only a repetition of that I have juſt ſketched out. He traces out new furrows, which are always concentric with the firſt. The diameter of the circumference likewiſe gradually diminiſhes, and the piſmire ſinks himſelf from time to time deeper in the ſand.

But I muſt not omit to obſerve to you, that he never loads his head with any other ſand but that contained in the circumference of the furrow he is actually tracing out. It would be equally eaſy for him to load it with the ſand on the outſide of the circle, ſince the leg that anſwers to this ſide of the furrow is capable of the ſame functions as the correſponding one. You will never ſee him deviate from this method; he ſeems to know, that in order to hollow his trench, he has nothing to do but to remove from it the ſand compriſed in the area or circumference of the furrow. Wherefore that leg only on the ſide of the area is kept in action; the other remains quiet; but is ſet to work in its turn, when the former happens to be fatigued. The lion-piſmire is then ſeen to turn himſelf about from end to end, or to croſs the area in a right line, and begin a new furrow the contrary way. By this change of ſituation, the leg that was firſt placed on

the outſide of the area, is now found to be within it, and ready to purſue its operations.

It often happens that in digging this mill-hopper or trench, the piſmire meets with large grains of ſand, or little clods of dry earth: he takes care not to leave them in the trench: ſince they might ſerve as ladders to the little inſects that ſhould endeavour to eſcape from it. He loads his head with them, and by a ſudden and well-contrived motion, projects them from the hole.

If inſtead of ſuch light bodies as theſe he falls in with pebble ſtones, that are too heavy to be jerked away with his head, he knows how to get rid of them by a new and very extraordinary method. He comes out of the earth, and appears intirely expoſed. He goes backwards in this manner, till the extremity of his hind part has touched the ſtone. He then ſeems to feel for it; endeavours to puſh and raiſe it up; he redoubles his efforts, at laſt takes it upon his back, ſkilfully preſerves an equilibrium by the quick and alternate motions of his rings, gains the foot of the aſcent with his load, climbs up it, carries the ſtone to ſome diſtance from the hole, returns, and makes an end of digging it.

But notwithſtanding all his ſkill as an equilibriſt, the ſtone ſometimes ſlips from him juſt as he is on the point of arriving at the top. This does not diſcourage him, he goes down, ſeeks for the ſtone, lifts it again on his back, regains the ſummit, mounts it afreſh, unloads himſelf, and returns to his work.

His patience is almoſt inexhauſtible: he has been ſeen to perform the ſame taſk ſix or ſeven times ſucceſſively, having ſo often let the burden fall. It affords to the eyes of the aſtoniſhed and ſympathizing ſpectator, a very natural image of the unfortunate Siſyphus.

At

At laſt the lion-piſmire enjoys the fruit of his labours: he has laid his ſnare, and is now watching for the game. Concealed and motionleſs at the bottom of his hole he waits like a crafty and patient hunter for the prey he is not able to purſue. If an ant comes and nibbles round the precipice, it ſeldom fails to fall into it. The edges of it are ſteep, and eaſily moulder away. They carry along with them the imprudent ant, the piſmire ſeizes it haſtily with his horns, ſhakes it in order to ſtun it, draws it under the ſand, and ſucks it at pleaſure. He afterwards caſts away the carcaſe, which is then only a dry and empty ſkin, repairs the diſorder occaſioned to the trench, and lays again in ambuſcade.

He has not always the good fortune to ſeize his prey the inſtant it falls into the ſnare. It often eſcapes from his murdering paws, and ſtrives to gain the top of the tunnel. Then the piſmire puts his head in exerciſe, he repeatedly darts bits of ſand on the prey, that precipitate it again to the bottom of the trench.

I made mention * of a ſpider, that is ſo attached to her eggs as to carry them every where about with her. She incloſes them in a little ſilk bag, which ſhe faſtens to her hind part. It might be taken for the belly of the ſpider. She is very fierce, extremely active, runs with rapidity, and never parts from her eggs. A ſpider of this ſpecies being thrown into the trench of a lion-piſmire, the latter immediately ſeized the bag, and dragged it underneath the ſand. The ſpider ſuffered herſelf to be carried away with it; but the ſilk, which ſtuck cloſe to her hind-part, broke, and ſhe found herſelf ſeparated from it. She immediately turned back, caught hold of it with her paws, and uſed

* Part x, chap. 5.

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her utmoſt efforts to force it from the piſmire. Her attempts were ineffectual; that continued to convey the bag deeper under the ſand; and the ſpider, rather than quit her bag, ſubmitted to be buried alive. Being preſently dug out, ſhe appeared to be quite lively: the piſmire had not attacked her; nevertheleſs, tho' ſhe was touched ſeveral times ſucceſſively with a little ſplinter of wood, ſhe refuſed to ſtir: this ſpider, which before was ſo active, wild, and fierce, ſeemed unwilling ever to quit the ſpot where ſhe had loſt what ſhe held moſt dear.

When the lion-piſmire has attained his full growth, he quits the occupation of hunter, which is then become uſeleſs to him; he lays no more ſnares, and, after having walked for ſome time near the ſurface of the earth, ſinks into it, and conſtructs for himſelf there a cone of a ſpherical form, the inſide of which he lines with a ſattin tapeſtry, of the moſt beautiful grey tinged with a pearl colour, where he transforms himſelf into one of thoſe flies called *dragon-flies*.

There has been diſcovered a new ſpecies of lion-piſmire, which is very rare in theſe countries, and is ſomewhat larger than the common ſpecies. She is particularly remarkable for her method of alluring her prey; ſhe runs before it with great agility, and this is probably the reaſon why it has had no tunnel given to it. It is contented with concealing itſelf on the ſurface of the earth, and ſeizing the inſects in their paſſage. In all likelihood ſhe is ſenſible ſhe can outſtrip them when ſhe pleaſes.

Theſe ingenious proceedings, which have rendered the lion-piſmire ſo famous, are not peculiar to him. We are now made acquainted with a very different kind of inſect, which inhabits, like the other, a pulverized and crumbling earth, digs for himſelf a trench in it like a tunnel, and darts little quantities

quantities of ſand on the prey that endeavours to eſcape out of it. This inſect is a whitiſh worm, ſoft, and without legs, and has received the appellation of lion-worm, from its analogy to that creature whoſe actions it imitates. His tunnel is deeper in proportion at the opening than that of the lion-piſmire. In digging his trench, the lion-worm makes uſe of a very ſimple method. He does not begin, like the lion-piſmire, with tracing a circular furrow, for determining the aperture: he is not ſo good a geometrician: but contents himſelf with throwing out the ſand obliquely on all ſides. By excavating it after this manner he ſinks deeper and deeper into it, and thus continues to hollow and empty his trench, till he has given it the depth he thinks proper for it.

CHAP. XXXVIII.

The toad.

I Shall not heſitate about giving a deſcription of this hideous animal. His conſtancy in his amours, his indefatigable patience, and wonderful dexterity, will at once be found deſerving the encomiums of my readers. They may be ranked in the claſs of oviparous animals. Their eggs, which are very numerous, and covered over with a thick membrane, are twiſted together by a kind of thread. You are to form an idea of a long ſtring of beads, nearly equal in ſize. The female muſt diſcharge this, by rolling it about in her belly. It is a work of great labour to lay the firſt egg; but when that is effected, the reſt is attended with little trouble, ſince the male always lends his aſſiſtance. The moſt experienced midwife does not with greater ſkill perform the duties of her function, than this officious and

and diligent male executes his. Having ſquatted himſelf for a longer or ſhorter time on the back of his female, he embraces her eagerly with his fore-paws while with his hinder ones he takes hold of the firſt egg and the end of the ſtring. This ſtring he twiſts between his toes, ſtretches out his paws, and extracts the ſecond egg; then ſeizing with the other paw that part of the cord which is higheſt, he draws out the third, which is ſoon followed by the fourth. By reiterating this ſkilful proceſs, he has the good fortune at length to extract the whole ſtring.

CHAP. XXXIX.

The ſubtleties of the hare and ſtag.

IF the hare does not poſſeſs, like the rabbet, the art of digging for himſelf a burrow*, he does not however want a ſufficient degree of ſagacity to enable him to ſecure himſelf, and eſcape from his enemies. He can chooſe for himſelf a form, and conceal himſelf betwixt clods of earth that reſemble the colour of his hair. In winter, he takes up his lodging to the ſouth, and in ſummer time to the north; when ſtarted by the dogs, he purſues the ſame track for ſome time, goes the ſame way back again, darts aſide, throws himſelf into a buſh, and there ſquats down. The pack follow the path, paſs before the hare, and loſe ſcent of him.

The crafty animal ſees them paſs by and run far from him, he iſſues from his retreat, confounds his courſe, and puts the hounds to a loſs. He varies his ſhifts continually, and always conducts them as his circumſtances require. Sometimes at the cry

* Chap. 25. of this part.

of

of the hounds, he quits his form, ſpeeds away to the diſtance of a quarter of a league, caſts himſelf into a pond, and lies hid among the ruſhes. At others he mingles with a flock of ſheep, and will not abandon them. One time he conceals himſelf under-ground: at another leaps under a ruinous wall, crouches among the ivy, and lets the dogs paſs him. Oftentimes he runs along one ſide of a hedge, whilſt the dogs go on the other. Sometimes by ſeveral efforts he ſwims acroſs a river. Laſtly, at others he obliges another hare to quit the form, in order to ſupply his place, &c.

The ſtag, which by the elegance and lightneſs of his make, by thoſe living *branches* with which his head is rather adorned than armed, his ſize, ſtrength, and noble air, is one of the grand ornaments of the foreſt, is endued with more ſubtilty than even the hare, and finds more exerciſe for the ſagacity of the huntſman.

When purſued by the hounds, he paſſes and repaſſes ſeveral times on his track; eludes their purſuit by aſſorting himſelf with other beaſts, darts forward, and immediately flees to a diſtance, ſtarts aſide, and ſteals away, and lies proſtrate on his belly. The land betraying him every where, he betakes himſelf to the water. The hind that nouriſhes her young, preſents herſelf to the dogs, in order to facilitate the eſcape of her young, ſhe runs away with ſwiftneſs, and afterwards returns to it.

CHAP. XL.

The fox.

THE fox, celebrated for his ſubtilty, and that acts ſo conſiderable a part in thoſe ingenious fables wherein morality is ſo conſpicuouſly diſplayed;

ed; the fox, I ſay, conducts himſelf with as much prudence as ſagacity; no leſs circumſpect than ſkilful, no leſs vigilant than crafty, he weighs cautiouſly the leaſt of his meaſures, ſtudies circumſtances, watches inceſſantly, never acts without effect, and has always ſome contrivance in reſerve to aſſiſt him upon an exigency. His genius, ſo fruitful in reſources, multiplies almoſt to infinity his tricks, ſhifts, and ſtratagems.

Tho' extremely fleet in running, he does not truſt to his natural ſwiftneſs: he judges that that alone would not be always ſufficient for his preſervation. He works for himſelf a timely aſylum under ground; where he takes refuge in caſe of neceſſity, and lodges and brings up his family.

He eſtabliſhes his dwelling place on the border of woods, and in the neighbourhood of farm-houſes. He liſtens afar off with an attentive ear to the cackling of poultry, directs his ſteps accordingly, conceals them with great ſkill and precaution, arrives by ſeveral winding ways, ſquats himſelf down, paſſes along on his belly, lies in ambuſcade, and rarely fails in his attempt.

If he is ſo happy as to be able to penetrate into the incloſure, he employs to good purpoſe every moment of his time, and ſlaughters the whole ſtock. He immediately retreats, carries away with him one of the prey, conceals it, returns, in ſearch of another, hides that like the former, and does not ceaſe from plundering till he perceives he has been diſcovered.

He is amazingly ſkilful in hunting young leverets, ſurpriſing the hares when lying down; in diſcovering the neſts of partridges, quails, &c. and ſeizing the mother on her eggs.

Equally bold as crafty, he has even the courage to attack bees: he attempts to get their honey,

which he is very fond of. Theſe warlike inſects preſently aſſail him on all ſides, and in a few moments he is entirely covered with them. He retires to ſome paces diſtance, rolls himſelf on the ground, cruſhes them by that means, returns to the charge, and at length obliges this little laborious people to abandon to him the fruits of their long labours.

I ſhall add but one more inſtance: if the fox diſcovers that his young have been diſturbed during his abſence, he tranſports them one after another to a new place of retreat.

CONCLUSION.

HERE do I ſet bounds to my deſign. I have preſented my readers with a variety of facts of an intereſting nature, ſufficient to enable them to form an idea of thoſe pleaſures which reſult from the contemplation of nature. But this contemplation would prove fruitleſs, did it not lead us to aſpire inceſſantly after this adorable BEING, by endeavouring to acquire a knowledge of him from that immenſe chain of various productions wherein his power and wiſdom are diſplayed with ſuch diſtinguiſhed truth and undiminiſhed luſtre. He does not impart to us the knowledge of himſelf immediately; that is not the plan he has choſen; but he has commanded the heavens and the earth to proclaim his exiſtence, to make himſelf known to us. He has endued us with faculties ſuſceptible of this divine language, and has raiſed up men whoſe ſublime genius explores their beauties, and who become their interpreters. Impriſoned for a while in a ſmall obſcure planet, we only enjoy ſuch a portion of light as is ſuitale to our preſent condition; let us wiſely improve each glimmering ray reflected

upon us, nor lose the smallest spark: let us continually advance in this effulgent light! A time will come when shall draw all light from the Eternal Source of light; and instead of contemplating the Divine Architect in the works of his hands, we shall then contemplate the workmanship in the omnipotent Author thereof. "We now see things "obscurely, and as through a glass darkly; but "we shall then see face to face."

FINIS.

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